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ABSTRACT

Needs pertaining to changes in standards for California higher education facilities for the disciplines of engineering and the biological and physical sciences are reviewed in this publication. Aspects related to the study include: (1) a history of how space and utilization standards have been developed in California; (2) an overview of the mechanics for standards development; (3) a summary of space and utilization standards used in other states; (4) selected views of university officials on current standards for engineering and the natural sciences; (5) an analysis of changes over recent decades that have affected space needs; and (6) findings, conclusions, and recommendations of the study commission. It is proposed that implementation of the recommendations cover a two year interim period and that a more comprehensive plan be developed for the future. (ML)

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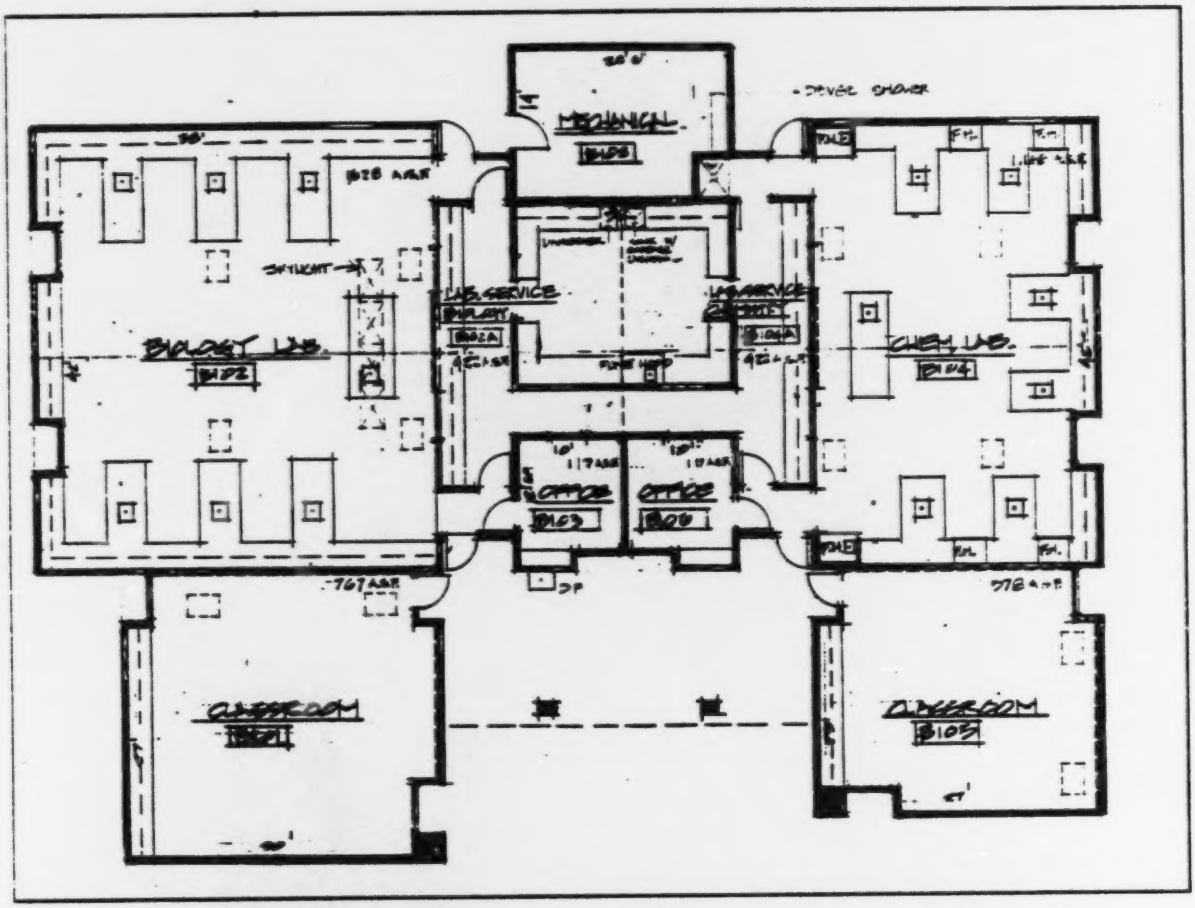
TIME AND TERRITORY

A Preliminary Exploration of Space and Utilization Guidelines in Engineering and the Natural Sciences



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Summary

This report completes the first phase of a two-part study called for by the Legislature in Supplemental Language to the 1985-86 Budget Act. The Legislature asked the Commission, first, to recommend by 1986 any needed changes in space and utilization standards in California public higher education for the disciplines of engineering and the biological and physical sciences, and second, to offer by April 1986 a plan for studying the standards of all other disciplines.

This response to the first of these requests contains an introduction that explains the reasons for the study and the procedures followed by the Commission in conducting the study, and then six chapters:

1. A history of how space and utilization standards have been developed in California;

2. An overview of the mechanics for developing these standards;

3. A summary of space and utilization standards used in other states;

4. The views of officials of the University of California and the California State University on California's current standards for engineering and the natural sciences;

5. An analysis of changes over recent decades in engineering and the natural sciences that have affected their space needs; and

6. The Commission's findings, conclusions, and recommendations.

On pages 64-66 of the report, the Commission offers seven recommendations for implementation during a two-year interim period ending on July 1, 1988 -- by which time it expects a more comprehensive analysis of the subject to be completed. Its recommendations that relate specifically to the existing standards seek to (1) create greater flexibility in capital planning by substituting the term "guidelines" for "standards"; (2) relax the existing utilization standards for classrooms and teaching laboratories in California's two public universities; and (3) increase the space allocations for research laboratories at the University of California.

The Commission adopted the report on February 3, 1986, for transmittal to the Legislature and other interested parties. Additional copies of the report may be obtained from the Publications Office of the Commission. Further information about the report may be obtained from Suzanne Ness, the public information officer of the Commission, at (916) 322-0145.

TIME AND TERRITORY

A Preliminary Exploration
of Space and Utilization Guidelines
in Engineering and the Natural Sciences

CALIFORNIA POSTSECONDARY EDUCATION COMMISSION
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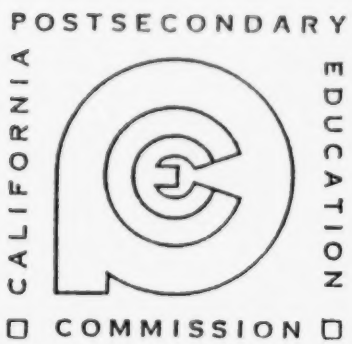

COMMISSION REPORT 86-2
FEBRUARY 1986

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Contents

Introduction 1

1. Development of Space and Utilization Standards in California Public Higher Education 3

Space and Utilization Standards -- Definitions and Need 3
Space and Utilization Standards in California Since 1947 4
The 1955 Restudy 5
The 1960 Master Plan 5
The 1966 Coordinating Council Report 5
Recommendations of the Legislative Analyst 8
Recent Developments 9

2. The Mechanics of Space and Utilization Standards 11

Inventories of Current Space 11
From Descriptive Inventory to Prescriptive Standards 12
Disagreement Over Needed Space 13
Conclusion 18

3. Space and Utilization Standards in Other States 21

Alabama 21
Alaska 23
Kansas 23
Illinois 23
South Carolina 24
Nebraska 24
North Carolina 30
Ohio 32
Texas 32
Virginia 37
Florida 37
New York 40
Summary 42

4. **University of California and California State University Perspectives on Space and Utilization** 45

University of California 45
The California State University 48
California Community Colleges 51
Summary 51

5. **Changes in College and University Research Funding and Staffing** 53

Growth of Research Funds 53
Growth of Postdoctoral Research 53

6. **Findings, Conclusions, and Recommendations** 61

Findings 61
Conclusions 63
Recommendations 64

References 67

Displays

1. Recommended Standard Instructional Floor Areas per Student for Classrooms, Teaching Laboratories, and Graduate-Student Research Laboratories in State Colleges and the University of California 6

2. Percentage Distribution of Gross Square Feet in California Institutions of Higher Education 11

3. Distribution of Non-Residential Assignable Square Feet in California Public Higher Education by Types of Rooms 12

4. 1966 Coordinating Council Space Formula 13

5. 1966 Coordinating Council Utilization Standards for Classrooms and Teaching Laboratories 14

6. 1966 Coordinating Council Space Standards for Academic Classrooms and Teaching Laboratories 14

7. Recommended Standard Staff Floor Areas for Instructional Departments at the California State Colleges and the University of California 16

8. Comparison of Standard Staff Floor Areas for Instructional Departments as Recommended by the 1955 Restudy and as Implemented in the University of California's Space Summary Analysis 17

9. Assignable Square Feet (ASF) of the University of California's Instruction and Research Facilities Covered or Not Covered by 1955 Restudy or 1966 Coordinating Council Space Standards in 1984-85 18

10. California State University Utilization Rates for Classrooms and Laboratories, Fall 1983 19

11. Classroom and Teaching Laboratory Utilization and Space Factors at the Six Largest Institutions of Higher Education in Alabama, Fall 1980, Compared to Similar Factors at the California State University, Fall 1983 22

12. Classroom and Laboratory Utilization at the University of Alaska, Fall 1982, Compared to That of the California State University, Fall 1983 23

13. Daytime Classroom Utilization Rates and Guidelines at South Carolina Institutions of Higher Education (8 a.m. to 5 p.m.), Compared to California Standards 25

14. Daytime Laboratory Utilization Rates and Guidelines at South Carolina Institutions of Higher Education (8 a.m. to 5 p.m.), Compared to California Standards 26

15. Number of Classrooms Scheduled per Week at Nebraska Colleges and Universities 27

16. Number of Class Laboratories Scheduled per Week at Nebraska Colleges and Universities 27

17. Classroom Space Standards in Sixteen States 28

18. Laboratory Space Standards in Fourteen States 29

19. Space Factors for Various Disciplines in Eleven States, 30

20. North Carolina Class Laboratory Standards by Discipline (Including Service Areas), Compared to California Standards 31

21. Ohio Space and Utilization Standards for Classrooms 33

22. Ohio and California ASF/Station Standards for Laboratory Facilities 33

23. Ohio Station Utilization in Classrooms and Teaching Laboratories Compared to the Ohio Standards 34

24. Texas Classroom Space Allowances 35

25. Texas Teaching Laboratory Standards for Engineering and the Natural Sciences in Assignable Square Feet per Station and per Student Station Periods of Occupancy (SSPO), Compared to California Standards 36

26. Virginia 8 a.m. to 5 p.m. Classroom Space and Utilization Standards Based on Total Full-Time-Equivalent Day Enrollment, Compared to California 8 a.m. to 10 p.m. Standards 38

27. Virginia 8 a.m. to 10 p.m. Classroom Space and Utilization Standards Based on Total Full-Time-Equivalent Day and Evening Enrollment, Compared to California 8 a.m. to 10 p.m. Standards 38

28. Virginia 8 a.m. to 5 p.m. Teaching Laboratory Space and Utilization Standards Based on Total Full-Time-Equivalent Day Enrollment, Compared to California 8 a.m. to 5 p.m. Standards 39

29. Virginia 8 a.m. to 10 p.m. Teaching Laboratory Space and Utilization Standards Based on Total Full-Time-Equivalent Day and Evening Enrollment, Compared to California 8 a.m. to 10 p.m. Standards 39

30. Recommended Values for Space Utilization Standards and Standardized Space Factors in Florida University's Compared to California 40

31. Florida Standard Station Area Values for Teaching Laboratories in Engineering and the Natural Sciences Compared to California Standards 40

32. Florida Space Standards for Research Laboratories, Compared to California Standards 41

33. State Funded University of California Capital Outlay Projects for Science and Engineering (Excluding Health Sciences) Contained in the 1985-86 Governor's Budget and the 1986-87 Regents' Request 46

34. Percentage Variations from Existing Space and Utilization Standards in the University of California's Capital Outlay Plans for its Eight General Campuses, 1989-90 47

35. State Funded California State University Capital Outlay Projects for Science and Engineering Contained in the 1985-86 Governor's Budget and the 1986-87 Trustees' Request 50

36. Research and Development Expenditures at Universities and Colleges by Year and Character of Work: Fiscal Years 1953-82 (Current Dollars) 54

37. R&D Expenditures at Universities and Colleges by Year and Character of Work: Fiscal Years 1953-82 (Constant Dollars) 55

38. Total R&D Expenditures at Educational Institutions and Number of Scientists -- Selected Disciplines, 1972-1982 (Thousands of Dollars) 56

39. University of California Expenditures from Extramural Funds (Five-Year Intervals Beginning in 1950-51) 57

40. Institutions Ranked by Science/Engineering Postdoctorate Utilization and Research and Development Funds Received from All Sources, 1983 58

Introduction

SUPPLEMENTAL language to the 1985-86 Budget Act contained the following directive:

> *Item 6420-001-001, Number 4.* Capital Outlay Guidelines. The California Postsecondary Education Commission (CPEC) shall study the current space and utilization standards for undergraduate class and graduate laboratories and faculty research/ office space in public higher education. By December 1, 1985, the CPEC shall report its recommendations for changes, if found necessary, to the existing space and utilization standards for the disciplines of engineering, biological sciences, and physical sciences to the Chairs of the legislative fiscal committees and the Joint Legislative Budget Committee (JLBC). The CPEC shall provide a report on the status of its review and plan to complete the study for all remaining disciplines, to the same committees by April 1, 1986. It is legislative intent that any revisions in the current space and utilization standards will be incorporated into the capital outlay programs for the 1986-87 budget.

To respond to the first part of this request, the Commission submits this six-part report which is organized into:

1. An introduction to space and utilization standards in California higher education;
2. A discussion of the mechanics of space and utilization standards;
3. A summary of guidelines and standards in other states;
4. A presentation of the perspectives of the University of California and the California State University on the subject;
5. A discussion of the specific problems of space endemic to engineering and the sciences; and
6. Findings, conclusions, and recommendations.

Scope of the report

Throughout the report, the Commission pays most attention to the three disciplines mentioned in the supplemental budget language -- engineering, biological sciences, and physical sciences. It gives virtually no attention to the California Community Colleges -- not because of a lack of concern for the space and utilization problems of these colleges but because of the time constraints of this brief and preliminary study, and because the Legislative Analyst indicated that the Legislature's principal interest in the study was directed at California's two public universities rather than its Community Colleges. In the Commission's larger effort to commence this spring, the Community Colleges will certainly be included.

In this report, the Commission does not offer definitive new standards in engineering, the natural sciences, or any other discipline. Space and utilization studies conducted in the past have required years of data collection and study, and there is no doubt that for an adequate study, at least as much effort will have to be directed to the current study as was expended in the past. The subject may be no more complex than in the past, but there is no question that California's institutions of higher education have increased in both size and programmatic diversity, and this alone will make any examination a difficult one. Nevertheless, it is possible to begin the process of updating standards or guidelines that may or may not be archaic, and the Commission believes that the first step in this process must be to familiarize policy makers with the subject, both in terms of California's experience and the experiences and practices of other states. In this way, it is possible to view California's standards in light of what others in the field believe are reasonable. In addition, this report can serve as a forum for the segments to present detailed comments and perspectives on the problems they face, in order to give greater focus to the future stages of what will probably be a multi-year project.

Only because the Supplemental Language requires it does the Commission offer recommendations in

this report concerning the space standards in engineering and the natural sciences to be used for reviewing the 1986-87 State Budget. In doing so, the Commission freely expresses its reluctance to offer long-range recommendations, for it is clear that there has not been sufficient time to develop viable standards that can stand for a number of years. Therefore, the Commission's proposed interim guidelines in Chapter Six are based on a combination of segmental preferences, the standards of other states, and as much independent evidence concerning space requirements in engineering and the sciences as could be collected quickly. In developing the report in this way, the Commission is well aware that the preferences of the segments may not be entirely acceptable to the Legislature (hence the Supplemental Language requesting this report) and that the practices in place in other states may not be precisely applicable to conditions in California. Such "custom fitting" will have to await the results of a study far more comprehensive than this one has been allowed to be.

Notwithstanding these reservations, the Commission submits this report to the Legislature to aid in legislative deliberations of capital outlay for the California State University and the University of California in the 1986-87 budget. By April 1986, it will submit a second report that will include a complete plan for the reexamination of space and utilization standards on all public campuses and for all disciplines.

Development of the report

To assist in the preparation of this report, the Commission convened a technical advisory committee consisting of representatives from the segments, the Department of Finance, and the Office of the Legislative Analyst. That committee met on two occasions, first to discuss the general nature of the subject and the direction the study should take, and second to review a draft of the report. Commission staff also held many conversations with individual members of the advisory committee and reviewed a large number of documents and publications, including many from facilities planning agencies around the country, and from the National Science Foundation. In addition, staff made several visits to University of California campuses in an effort to determine the condition and adequacy of the University's scientific laboratories. These visits involved a number of conversations with administrators as well as faculty members, graduate students, and other researchers -- including postdoctoral fellows -- in the fields covered by the Supplemental Language.

Several people have been of considerable assistance in preparing this preliminary report. Principal among them are Trudis L. Heinecke of the Office of the President of the University of California: Sheila Chaffin and William Chatham of the Office of the Chancellor of the California State University: and Jon Regnier of California State University, Long Beach -- all of whom served on the technical advisory committee.

The Commission would also like to extend its appreciation to Gerald Beavers and Richard Keller of the Office of the Legislative Analyst. Other advisory committee members who were helpful at various stages of this project include Clarence Mangham and Matt Fugina of the Chancellor's Office of the California Community Colleges, and Robert L. Harris, Robert Gray, and Stanley L. Lena of the State Department of Finance. Much assistance was also provided by individuals on several University of California campuses who developed background papers, and by capital planning experts in many other states who were willing to forward data to Commission staff and to discuss those data over the telephone, but they are too numerous to mention here.

1 *Development of Space and Utilization Standards in California Public Higher Education*

Space and utilization standards -- definitions and need

One of the least understood aspects of State budgeting for higher education is the process that leads to the development of capital outlay programs. Compared to the issues of dollars per student, salaries and benefits, student financial aid, and faculty workload, the consideration of bricks and mortar often seems mundane. Yet every year, the State of California appropriates millions of dollars for the construction of new buildings, the renovation of old ones, the furnishing of equipment, and the installation of utilities. Most of these projects are heavily influenced by the application of space and utilization standards, for it is through such applications that the sizes of buildings, and therefore their cost, are determined.

Certain terms and abbreviations need to be displayed here to avoid confusion later. Those of greatest importance include:

Assignable square feet (ASF): The number of interior usable square feet in a building, to be distinguished from gross square feet.

Gross square feet (GSF): The total area covered by a building as measured from the exterior walls.

Station: A seat in a classroom, work area in a laboratory, carrel in a library, or the like.

Weekly room hours (WRH): The number of hours in a week that a particular facility (classroom or laboratory in most cases) is occupied for instructional purposes.

Weekly student contact hour (WSCH): One student sitting in a classroom or laboratory for between 30 minutes to one hour. A student attending three one-hour lectures a week would generate three weekly student contact hours. This is sometimes noted as "weekly student hours" (WSH); the terms are interchangeable.

Student credit hour (SCH): The number of semester or quarter units taken by one student. In almost all cases, a student will generate more weekly student contact hours than student credit hours. Students in laboratory courses may generate as many as three laboratory weekly student contact hours for one student credit hour.

Full-time equivalent (FTE): A measure of full-time load. Normally, one full-time equivalent student is one student taking 15 student credit hours of work. For budgeting purposes, a full-time equivalent can be such a student, three students taking five student credit hours, five students taking three student credit hours, or any other combination producing a product of 15 student credit hours.

Space standard: As employed in California, a "space standard" can be defined as the number of assignable square feet per student or faculty station. These numbers vary greatly by type of space and by academic discipline; they are applied to classrooms, teaching laboratories, research laboratories, offices, libraries and several other kinds of spaces.

Utilization standard: Refers to the number of hours in a week that a particular facility, or a station in that facility, should be used. This can be based on weekly room hours, station use (such as. a seat in a lecture hall or a work area in a laboratory), or a combination of the two. In California, both standards are normally applied (as in the current classroom standard for all of public higher education of 53 weekly room hours with two-thirds of the seats in each room occupied while the class is in session).

Space factor: Since the late 1960s, California has employed a third measure called the "space factor," a combination of all the other measures that provides for assignable square feet per weekly student contact hour or full-time equivalent, and it is that measure that ultimately determines the total number of square feet a particular building in a particular segment will be allowed. It is discussed further beginning on page 13.

Space planning involves the calculation of several other numbers and the manipulation of various formulas, but all of them relate back to space stand-

ards, utilization standards, or space factors. All of the rest essentially involve conversions of weekly student contact hours to full-time equivalents or to student credit hours or vice versa, or gross square feet to assignable square feet.

Space and utilization standards are important because they introduce consistency and rationality to the process of capital planning and allow all campuses in all segments to be treated equitably. Were it not for the existence of standards, each proposal would have to be evaluated individually, and there would be no practical way to determine relationships among various kinds of space or to provide for the balanced development of campuses With standards, it is more likely that space allocations will be balanced among a variety of uses, and that planners will give earnest consideration to the true square footages classrooms, laboratories, and other facilities require. The very existence of standards, therefore, forces both the State and the segments to engage in a process of exploration, analysis, and evaluation. It is a process intimately linked to a cardinal principal of the Master Plan, that the development of higher education will be "orderly."

Space and utilization standards in California since 1947

In 1947, the Legislature authorized a major study of the needs of higher education in California that led to *A Report on a Survey of the Needs of California in Higher Education*, by George Strayer, Monroe E. Deutsch, and Aubrey A. Douglass. At that time, the University of California operated four general campuses that together enrolled 40,000 students; the State Colleges enrolled 20,000 students, and the 55 public junior colleges enrolled about 60,000 students. The Legislature commissioned the 1948 study because it correctly foresaw that California was entering a period of explosive growth, that such growth would place intolerable demands on the already overcrowded existing campuses, and that much of the State's future prosperity would depend on the existence of an extensive and high quality system of higher education.

Many options confronted the Strayer Committee, including the expansion of existing campuses, the extensive use of temporary facilities, the building of new campuses, and the greater utilization of existing space. As history has shown, California has used all of these options in varying degrees. Strayer and his associates approached their task by asking a number of questions quite similar to those being asked today:

1. Are the existing facilities in the institutions of higher education of the State being used to the maximum degree consistent with good educational practice?
2. What is the maximum number of students that can be accommodated at each campus with existing facilities without overcrowding classes, limiting the curricular offerings, or overextending the school week?
3. Are the present college and university plants properly proportioned as to number of each type of laboratory and general classroom or have shifts in student interests caused a condition of unbalance? (p. 84)

As was common practice throughout the country at the time, the Strayer Committee considered only the utilization of classrooms, devoting no attention to teaching laboratories or to the amount of space a particular classroom should occupy. It also failed to consider such areas as research laboratories, libraries, or faculty offices. In considering classroom utilization, it shunned the idea of operating in the evenings, stating that:

> It is the consensus of many of the foremost leaders in education that a school week in excess of forty five hours is unsatisfactory. Particularly is this true when many of the students attending our schools have to commute daily from points as far distant as from thirty to fifty miles. Even should the number so affected by relatively low, their existence so complicates the entire school schedule as to make the practice of extending the school week by ten, twenty, or thirty hours a very questionable one (pp. 84-85).

The Strayer Committee argued that various factors made the full utilization of classrooms and laboratories impossible, and it consequently recommended a net utilization factor of 65 percent of the forty-five available hours. It thus recommended that classrooms be used for 29 hours each week. At the time, almost every four-year campus in the State was already operating its classrooms for a greater number of hours than that.

The 1955 Restudy

For the next seven years, the staff of the Liaison Committee of the Regents and the State Board of Education continued their work on the planning of higher education facilities, and in 1954 were joined by T. R. McConnell to undertake what came to be titled *A Restudy of the Needs of California in Higher Education*. In this 1955 report, McConnell and his colleagues raised many of the same questions posed by the Strayer Committee in 1948, but they went considerably further in both expanding the scope of the standards and in refining them:

- Where the 1948 report had considered only the number of hours classrooms should be used, the Restudy authors considered both classroom and laboratory hours and the utilization of stations within those rooms. They debated multiple standards as well, considering the possibility of different standards for varying sizes of classrooms and laboratories, and established space standards for the first time.
- They called for general classrooms to be used 36 hours per week with 67 percent of the stations occupied in each of those hours. This represented 80 percent of the hours available in a forty-five hour week (8:00 a.m. to 5:00 p.m., Monday through Friday).
- For teaching laboratories, they recommended standards of 24 hours per week with 80 percent occupancy.
- They were the first California study group (and remain the only one) to offer precise space standards for faculty research laboratories at the University of California, and they developed standards for office and auxiliary spaces, as will be discussed in Chapter Two.

Except for research laboratories, the Restudy authors presented all of these standards in terms of "net square feet per total full-time equivalent student" -- a somewhat awkward measure that required computations of class size, student/faculty ratio, and other measures if area per student station was to be determined. In subsequent analyses, the term "assignable square feet" (ASF) came into common usage, and it was usually applied on a student-station basis. Display 1 on the next page shows the results of their deliberations for classrooms and laboratories.

The 1960 Master Plan

In 1960, the Master Plan Survey Team also explored the subject of space and utilization standards, but it was sufficiently satisfied with the work performed in the 1955 Restudy that it offered no new recommendations on space standards. Its Technical Committee on Institutional Capacities and Area Needs did, however, give considerable attention to the utilization standards recommended in the Restudy. In a report prepared for the Master Plan Survey Team, the Technical Committee noted that the utilization standards were "approved *as a goal* by both the State Board of Education and the University of California" and reported on the segments' progress in implementing the Restudy recommendations as follows:

> It is important to keep in mind that these standards, although based upon verifiable data, are still judgments, and may be either too low or unreasonably high. There is to date no evidence that will prove conclusively what can and what cannot be achieved. The University of California is using Restudy standards in projecting its building needs, but it is the studied opinion of the chief planning analyst for the University that these standards cannot be achieved. The experience of the state colleges has caused the Department of Education, with the consent of the State Department of Finance, to adopt standards somewhat below the Restudy standards. (Technical Committee, p. 23)

Convinced by this argument, the Master Plan Survey Team recommended a liberalization of the utilization standards to 30 hours per week at 60 percent station occupancy for classrooms and 20 hours per week at 80 percent station occupancy for laboratories. It also recommended that the soon-to-be-established Coordinating Council for Higher Education "undertake without delay . . . a complete study of the current utilization in the junior colleges, state colleges, and the University of California" (1960, pp. 96-97).

The 1966 Coordinating Council Report

A task soon undertaken by the Coordinating Council for Higher Education was the implementation of the Survey Team's recommendation, and in a September 1966 report, it offered new and comprehensive space

DISPLAY 1 *Recommended Standard Instructional Floor Areas per Student for Classrooms, Teaching Laboratories and Graduate-Student Research Laboratories in State Colleges and the University of California*

		Net Square Feet per Total Full-Time Equivalent Student in the Level of the Subject Field			
			Teaching Laboratories		
General Subject Field	Level of Instruction	Classrooms: University of California and State Colleges	State Colleges	University of California	Research Laboratories (University of California Only)
1	2	3	4	5	6
Agriculture	Lower Division	7.1	41	41	--
	Upper Division	7.2	63	63	--
	Graduate	1.7	100	--[a]	200
Arts	Lower Division	6.5	36	36	--
	Upper Division	6.2	53	53	--
	Graduate	5.3	60	--	140
Engineering	Lower Division	5.4	95	95	--
	Upper Division	7.5	96	96	--
	Graduate	2.3	--	--[a]	200
Languages and Literature	Lower Division	11.9	--[b]	--[b]	--
	Upper Division	9.5	--[b]	--[b]	--
	Graduate	9.5	--[c]	--[a]	30
Mathematics	Lower Division	9.6	--[b]	--[b]	--
	Upper Division	9.5	--[b]	--[b]	--
	Graduate	9.5	15[c]	--[a]	30
Miscellaneous Professions[d]	Lower Division	8.7	31	31	--
	Upper Division	8.9	2	30	--
	Graduate	8.0	30	--	30
Biological Sciences	Lower Division	6.6	30	30	--
	Upper Division	7.2	38	38	--
	Graduate	1.8	60	--[a]	160
Physical Sciences	Lower Division	8.0	28	28	--
	Upper Division	8.0	42	42	--
	Graduate	1.8	80	--[a]	160
Social Sciences	Lower Division	9.5	3	3	--
	Upper Division	9.2	2	2	--
	Graduate	8.4	15	--[a]	30

a. Allowance included under research laboratory.

b. Allowance included in classroom area.

c. To be included with classroom area.

d. Education, journalism, law, librarianship, and social welfare.

Note: The number of full-time equivalent students in a given subject field and level of instruction, to which these unit areas are to be applied, is that which represents the *total* full-time equivalence of all courses at that level in that subject field, irrespective of the students' majors and levels of registration in the institution.

Source: McConnell, Holy, and Semans, 1955, p. 345, Table 33.

and utilization standards for both classrooms and teaching laboratories. It did not, however, recommend any changes in the area standards established by the 1955 Restudy for faculty research laboratories.

The Coordinating Council developed a number of techniques and measures not previously employed in California. Rather than computing space needs on the basis of net square feet per full-time equivalent student, it opted for a measure of assignable square feet per station. Eschewing the use of full-time equivalency further, it preferred the use of weekly student contact hours and defined its space standards in terms of assignable square feet/weekly student contact hours (ASF/WSCH). As will be shown in Chapter Three, this approach is now popular in most other states.

The Coordinating Council operated under four fundamental assumptions that undoubtedly had a major impact on its conclusions and recommendations:

1. *The standards should allow maximum flexibility:* This assumption was designed to allow architectural flexibility, not a deviation from the standard itself. In other words, if a chemistry building was planned, the Council was unconcerned about the configuration of the space, but would insist that the total number of square feet fell within the confines of the standard.

2. *The standards, overall, should not be lowered below the Restudy standards*: The primary concern in this assumption was cost, as it was apparent that any significant liberalization of the Restudy standards would have a dramatic effect on the State budget.

3. *The standards should be equitable for all segments when concerned with the same levels of instruction and the same subject field areas:* This assumption was that space needs for certain types and levels of instruction would be identical in all three public segments. In other words, since all three public segments used classrooms for general instruction, the space and utilization standards for classrooms should be identical. Similarly, it was assumed that the space needs for upper division laboratories at the University and the state colleges were identical, hence a common standard for both.

4. *Standards should be continually reviewed:* The Council recognized that circumstances do change, and consequently recommended that continual reviews be undertaken: "Space standards should be periodically reviewed to keep up with changing times. New teaching techniques and practices, changing curriculum patterns, and new technology cause changes in the requirements for space " (p. 10).

The Coordinating Council proposed new and stricter utilization standards than had been recommended by the Master Plan, although they were lower than proposed in the Restudy. Where the Master Plan Survey Team had suggested standards of 30 hours per week per classroom with 60 percent station occupancy, the Council proposed a standard of 34 hours with 66 percent occupancy. Similarly, where the Master Plan called for laboratory use of 20 hours at 80 percent occupancy, the Council proposed a dual standard of 25 hours at 80 percent for lower-division instruction and 20 hours at 80 percent for upper-division instruction. Although the upper-division standard was identical to the Master Plan recommendation, the overall effect was a more stringent basis for evaluating space needs.

With these use standards, the Council developed a formula which employed measures of assignable square feet/station as follows:

$$\frac{\text{assignable square feet per station}}{(\text{hours of room use per week})(\text{percent station occupancy})}$$

The principal analytical difference between the Restudy and the Council standards was the change from net square feet per full-time equivalent student to assignable square feet per weekly student contact hour. For example, where the Restudy proposed a figure of between 6.6 and 11.9 assignable square feet per full-time equivalent student for classrooms, the Council proposed .67 assignable square feet/weekly student contact hour. This assumed that the relationship between contact hours and full-time equivalency was between about 10 and 17 for regular classroom instruction, if both the space and utilization standards recommended in each of the two studies were comparable.

Although it cannot be determined precisely, it seems probable that they were not comparable. What seems to have occurred is a liberalization of the utilization standards from the Restudy but not from the Master Plan, and a restriction of the space standards. The net effect may have been very close to the recommendations contained in the Restudy, but as

subsequent events would demonstrate, the lower space standards would soon reduce the total amount of area to which the segments were entitled.

Recommendations of the Legislative Analyst

Immediately following publication of the Coordinating Council's 1966 report, the Legislative Analyst became interested in the subject of utilization standards. In the *Analysis of the Budget Bill, 1965-66*, the Analyst strongly implied that emerging data processing technologies might increase the efficiency of classroom and laboratory utilization still further, and he therefore offered the following recommendation:

> *We recommend that the California State Colleges and the University of California each study the feasibility of using computers for student registration procedures combined with class scheduling procedures and that each segment submit a progress report to the Joint Legislative Budget Committee by December 1, 1965, including plans to conduct a pilot study on one campus by fall, 1966.* Current space utilization in California's institutions, as reported in the Coordinating Council for Higher Education Report, demonstrates quite clearly that existing space is not being fully utilized (p. 305).

The following year, both of the four-year segments presented their reports. The University of California argued that greater utilization might not be possible even with the use of computers, but it agreed to conduct a pilot program on its Davis campus. The State Colleges claimed they did not have the data-processing capability for even a pilot project but agreed to conduct one with a special appropriation of $35,972. The Analyst countered this request by recommending that the colleges conduct the pilot study by taking the needed funds be taken from another data-processing appropriation within their budget.

In 1968, the University submitted its report on the Davis pilot project, but the Analyst found it to be unsatisfactory. He criticized the study on the grounds that the University did not seem sufficiently interested in increasing utilization, and he argued that the defeat of the 1968 higher education bond issue (Proposition 3), as well as increasing demand for higher education services, made serious attempts to increase utilization mandatory. Accordingly, in his 1969-70 report he recommended:

> *We recommend (a) that the Coordinating Council for Higher Education restudy existing space utilization standards, (b) that the University of California and the California State Colleges study and implement better utilization methods paying particular attention to automatic data processing applications and (c) that reports with recommendations be presented by the Coordinating Council for Higher Education, the University of California and the California State Colleges to the Joint Legislative Budget Committee by November 1, 1969 on this subject.*
>
> *We recommend that the University and the state colleges admit all qualified applicants using a capital outlay capacity standard based on utilization of classrooms at a level of 75 percent of the time period 8 a.m. to 10 p.m. five days per week rather than the current standard of 48 percent of the above time period* (p. 326).

The Analyst had already conducted a preliminary utilization study of his own, and continued to do so the following year. In his *Analysis of the Budget Bill, 1970-71*, he noted that the State Colleges were meeting the Coordinating Council standards, while the University was below the standards, but that "These comparisons are not very meaningful, however, if they are based on relatively low standards" (p. 341). He also found the reports submitted by the Coordinating Council and the segments to be unsatisfactory, and consequently reiterated his recommendation of the previous year, a recommendation that was embodied in Assembly Concurrent Resolution 151 during the 1970 legislative session and that created a classroom standard of 53 hours per week room usage with 66.6 percent station occupancy.

Developments during the 1970s

Arguments over the standards continued for the next two years, until in 1971 the Coordinating Council produced another report, *Inventory and Utilization Study for Public Higher Education*, in which it noted the complexity of the space and utilization problem and indirectly chided the Analyst for adopting too simplistic an approach. The Council noted that consideration should be given "to other factors

such as emphasis on level of instruction, patterns of attendance, geographic location, site limitation, environment, academic program, scheduling, and campus maturity" (p. iv). To analyze these factors, the Council hired Mathematica, Inc., of Princeton, New Jersey, to construct what became known as the Council's "Facilities Analysis Model" or "CCHEFAM." This model involved some rather sophisticated computer modeling and required the regular collection of massive amounts of data, so much so that it was finally abandoned due to the incapacity of campus data processing systems to manage it.

The Analyst, however, continued to insist on higher standards, and in 1973 succeeded in obtaining them, this time for laboratories. Supplemental Language to the 1973-74 Budget Act provided as follows:

> *Item 359. University of California-Capital Outlay.* The Regents of the University of California shall base their building space needs in class-laboratories on 110 percent (27.5 hours/week lower division, 22.0 hours/week upper division) of current 8 a.m. to 5 p.m. utilization standards. This planning standard shall be used *on an interim basis* until the Coordinating Council for Higher Education establishes 8 a.m. to 10 p.m. utilization standards for class-laboratories.
>
> *Item 361 and 362. State University and Colleges-Capital Outlay.* The Trustees of the State Universities and Colleges shall base their building space needs in class-laboratories on 110 percent (27.5 hours/week lower division, 22.0 hours/week upper division) of current 8 a.m. to 5 p.m. utilization standards. This planning standard shall be used *on an interim basis* until the Coordinating Council for Higher Education establishes 8 a.m. to 10 p.m. utilization standards for class-laboratories.

Following this action, no further reports on the subject of space and utilization standards were issued by any State agency, and the Analyst also fell silent on the subject. This was a seemingly odd occurrence, given the fact that so much sound and fury had been created around the subject for so many years, but there were several reasons for it. In part, the hiatus was caused by the fact that the Coordinating Council was eliminated and replaced by the California Postsecondary Education Commission. Probably of far greater importance, however, were the reduced enrollment pressures and the virtual elimination of capital outlay funding that characterized the 1970s. With the enrollment crunch of the 1960s seemingly a thing of the past, and with few buildings being built for any purpose, the need for greater space utilization seemed less pressing. Thus, although the Postsecondary Education Commission did continue for a time the work begun by the Coordinating Council, no publications resulted. Because of that, the "interim" standards of 1970 and 1973 became more or less permanent.

Recent developments

With the return both of prosperity and enrollment pressures in the 1980s, particularly at the University of California, it was probably inevitable that interest in the uses of space in higher education would be rekindled. For over ten years, the capital outlay appropriations to the public segments had been much reduced from previous levels, and maintenance budgets suffered major reductions. The result was a backlog of segmental requests that have now led to legislative appropriations for the construction of new buildings and the remodeling of old ones. For the 1985-86 fiscal year, capital appropriations to the four-year segments totaled over $200 million, mostly for the University of California, and in 1986-87, requests from those segments will exceed $280 million.

During hearings on the 1985-86 appropriations for the University of California, testimony by the University revealed that several requests in the biological and physical sciences were based on space allocations which exceeded those listed in the 1955 Restudy and the 1966 Coordinating Council report, while some in engineering were below the standards. The University presented a number of arguments for the variations, all of which are discussed in Chapter Four, but one of the results of the budget hearings was some confusion over the subject in general, and some doubt as to the viability of standards (particularly for research laboratories where no study has been undertaken since 1955) that have remained unchanged for twelve years at the least. It was because of those doubts that the Legislature adopted the Supplemental Language noted on page 1.

2 *The Mechanics of Space and Utilization Standards*

WHEN the Coordinating Council for Higher Education published its *Inventory and Utilization Study for Public Higher Education, Fall 1969*, the Council offered the view that "the first requirement of a utilization study is a current accounting of available space" (p. III-1). That statement is still valid. Indeed, a current accounting of available space is also the first requirement for a comprehensive space analysis designed to create new space standards, for as the analyses of both space and utilization proceed, the inventory of current space inevitably becomes a point of reference.

Inventories of current space

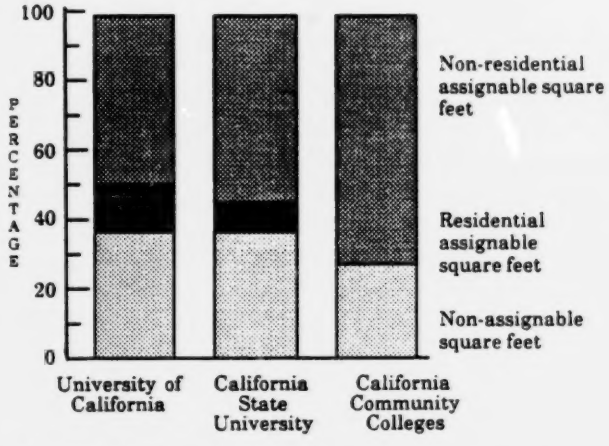
Higher education institutions make use of a wide variety of facilities, including administrative areas, offices, research laboratories, libraries, art galleries, student unions, theaters, storage and service buildings, and dormitories. Emphasis is often placed on their classrooms and teaching laboratories, but these spaces represent only half of the space available on California's Community College campuses and considerably less than half on its University and State University campuses.

Each one of California's three public segments of higher education maintains an inventory of all campus spaces.

- The University of California annually compiles an *Instruction and Research Space Summary Analysis* that categorizes all facilities into one of 124 types, arranges them by programmatic affiliation, shows the square footages involved, and indicates whether or not the space is subject to the space standards contained in either the 1955 Restudy or the 1966 Coordinating Council report. It does not, however, group those spaces by category, such as classrooms, laboratories, and the like.
- The State University publishes a similar report from its *Space and Facility Data Base* that categorizes space in 97 different ways, but it is compiled only on a campus-by-campus basis with no summary table for the system. There is also no indication of whether the facilities listed are subject to space standards or not.
- In the Community Colleges, a computerized space inventory is available for all colleges that categorizes all facilities into 80 types of space by room, building, college, district, and systemwide. It is updated regularly for use by districts in preparing the five-year capital outlay constuction plans that are required from all districts annually. The Chancellor's staff periodically reviews these space inventories for accuracy and proper classification. Unfortunately, there is some evidence indicating that the inventories available for some districts is not completely accurate.

It is anticipated that the Commission, in cooperation with the segments, will publish a comprehensive inventory of all space in public higher education within the next year, but there has not been sufficient

DISPLAY 2 Percentage Distribution of Gross Square Feet in California Institutions of Higher Education



Source: Adapted from Coordinating Council for Higher Education, 1971, p.III-5.

time to arrange the available data for presentation in this preliminary report. The most recent formal inventory was contained in the Coordinating Council's 1971 report. A recent update compiled by the segments in conjunction with this report is presented in Display 3 and it shows a number of significant changes in the distribution of space, not the least of which is a significant reduction in the total percentage of space devoted to classrooms and teaching laboratories in all three segments. Several things are immediately apparent from the three pie charts in Display 3:

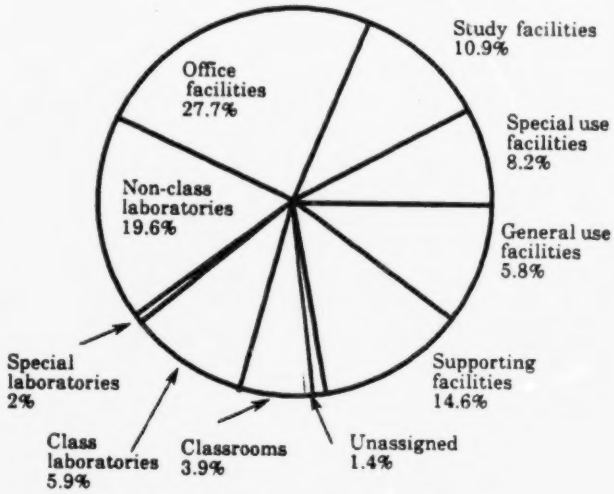
- First, the amount of space devoted to classrooms in the three segments differs substantially, ranging from five percent at the University of California to 16 percent in the Community Colleges.
- Second, teaching or "class" laboratories also vary considerably from a low of 10 percent at the University to 24 percent at the State University and 34 percent in the Community Colleges.
- Third, the University allocates 18 percent of its space to non-class and special laboratories, compared to 4 percent at the State University and none in the Community Colleges.
- Fourth, only in the area of general-use facilities is there any significant similarity among the three segments.

From descriptive inventory to prescriptive standards

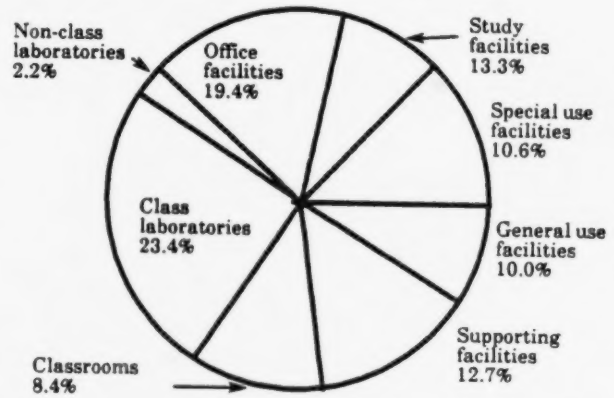
To a great extent, few displays illustrate the principle of segmental differentiation of function as dramatically as these space distributions, yet in spite of them, similarities remain for certain kinds of spaces, and all attempts to establish space and utilization standards have focused on them. For example, lower-division classrooms and class laboratories have traditionally been treated in the same way in all three segments, as have upper-division spaces of these types in the four-year segments. In California, classrooms are all allocated 15 assignable square feet per student station and all are required to be used 53 hours per week with 66 percent station occupancy. Similarly, while space allowances for teaching laboratories differ somewhat depending on the academic discipline, the standards for each discipline are applied evenly in all three segments, as are the utilization standards.

DISPLAY 3 Distribution of Non-Residential Assignable Square Feet in California Public Higher Education by Types of Rooms

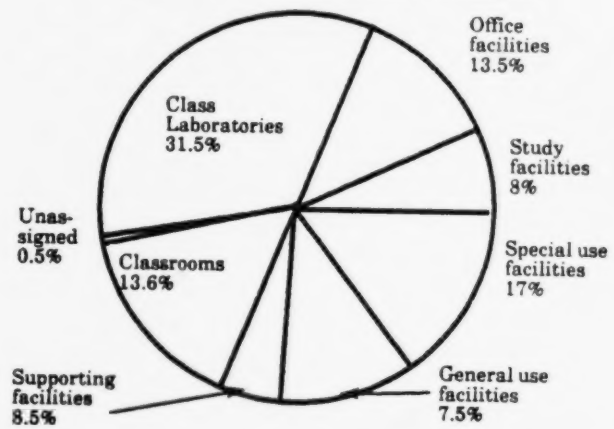
University of California



The California State University



California Community Colleges



Source: Adapted from Coordinating Council for Higher Education 1971, pp III-13-15

At present, the only rationale for differences among the three segments that has ever been accepted is a functional one, as in the Community Colleges, which have specific space allowances for vocational laboratories, or in the University of California for faculty research laboratories. Even in that latter case, however, the Department of Finance has an informal agreement with the State University under which the State University receives 75 percent of the University of California standard for graduate and faculty research space if this space can be demonstrated to be instructionally related. There have also been different standards applied for faculty offices, with the University of California receiving the highest allowance in recognition of the additional space needs occasioned by its research function.

As noted in Chapter One, California's process of establishing both space and utilization standards has undergone considerable evolution. The Strayer Committee in 1948 was concerned only with hours of use, making no distinctions among various types of space. It established a single utilization standard for classrooms, then included laboratories within that standard. It did not consider the question of the proper number of square feet those facilities should occupy, not did it consider space allocations or use patterns for offices, libraries, or other areas commonly included today. This approach changed in 1955 when the McConnell Committee established space standards for the first time and divided utilization standards between classrooms and laboratories, but even these lacked the precision that is needed to address modern institutions which are vastly more complex than they were in the 1950s.

In 1966, the Coordinating Council made a major contribution to facilities analysis when it developed the idea of relating square feet directly to the number of hours students actually occupy seats in classrooms and laboratories. This technique generated what has come to be known as the "space factor," a measure of assignable square feet per weekly student contact hour, shown in Display 4, and it was through the use of different factors for different disciplines and space types that it became possible to develop capital outlay requests based on a precise workload measure related directly to the level of instruction in specific courses.

Even though the 1955 Restudy categorized full-time equivalent students by major discipline, its workload measure -- level of student majoring in each field -- was much less satisfactory than a system based on course- and discipline-specific space allocations. As an example, a campus may propose a new biological sciences building based on a given number of students majoring in that category of disciplines, but this number of majors only indirectly relates to course taking in biology or a related field. Students majoring in biology or physiology do not take all their courses in that field. They also take courses in English, the humanities, and the social sciences, none of which affect the space requirements for biological science departments. At the same time, many students not majoring in biology take biology courses. Thus, while the use of full-time equivalent students provides an indication of space needs, it is far from a precise determinant.

A clearer picture of true needs is provided by measures of contact or credit hours. If it is known that a given number of students are actually sitting in classrooms or laboratories (contact hours) or taking certain specific courses (credit hours), workload measures are easily determined, and if those measures can then be related to both a space allowance and a utilization factor, the process of capital planning becomes more rational.

The Coordinating Council ushered in this process in 1966 by creating space factors that could be applied to all classrooms and teaching laboratories, regardless of discipline. With this formula, campuses and

DISPLAY 4 1966 Coordinating Council Space Formula

$$\frac{\text{ASF / Station}}{\text{Hrs. / Wk. x Stn. Occ.}} = \text{ASF / WSCH}$$

ASF/Station	=	Assignable square feet per student station.
Hrs./Wk.	=	Number of hours out of a 45-hour week, 8 a.m. to 5 p.m. a classroom, or laboratory, on the average, should be used.
Stn. Occ.	=	The percent of expected student station occupancy when rooms are in use.
WSCH	=	Weekly student contact hours.

Source: Coordinating Council for Higher Education, 1966, p. 8.

central offices, based on experience and a projection of trends, can determine their space allowances with great accuracy for about a three to five year period and compare them to all existing spaces contained within their operating inventories arranged in terms of total assignable square feet per discipline. The difference represents an entitlement to additional space or a statement of the adequacy of existing space, depending on whether the allowance exceeds or falls short of the square footage already in place.

Disagreement over needed space

All of this theory seems rather straightforward, but it conceals a world of complexity and controversy. There is no argument between the segments and State officials concerning the Coordinating Council's 1966 formula, but there has always been substantial disagreement over the factors to be applied to it. Over a three-year period, the Coordinating Council had debated the appropriateness of the standards before arriving at the space allotments and utilization standards shown in Displays 5 and 6.

DISPLAY 5 1966 Coordinating Council Utilization Standards for Classrooms and Teaching Laboratories

Type of Space	Hrs./Wk.		Stn. Occ.		Stn. Use
Classrooms and Seminars	34	x	.66	=	22.4
Teaching Laboratories:					
Lower Division	25	x	.85	=	21.3
Upper Division	20	x	.80	=	16.0

Source: Coordinating Council for Higher Education, 1966, p. 8.

It is axiomatic in the field of space analysis that small changes in the standards can have major effects on capital outlay funding. A case in point is the allotment for lower-division biological sciences at the University of California at Berkeley. For 1984-85, that campus counted 6,690.9 student credit hours for lower-division biological sciences -- an amount which would have entitled that campus to 17,396.3 assignable square feet of space. But when the Legislature changed the utilization standard from 25 hours of room use per week at 85 percent station occupancy to one of 27.5 hours per week at 85

DISPLAY 6 1966 Coordinating Council Space Standards for Academic Classrooms and Teaching Laboratories

Subject Field Area	ASF/ Station	ASF/ WSCH
Classrooms (All levels)	15	0.67
Life Sciences		
Agriculture		
Lower Division	60	2.80
Upper Division	60	3.75
Biological Sciences		
Lower Division	55	2.60
Upper Division	60	3.75
MPE Sciences		
Physical Sciences		
Lower Division	60	2.80
Upper Division	70	4.40
Mathematical Sciences		
Lower Division	30	1.40
Upper Division	30	1.90
Engineering Sciences		
Lower Division	90	4.25
Upper Division	110	6.90
Social Sciences		
Psychology		
Lower Division	40	1.90
Upper Division	60	3.75
All Other Social Sciences		
Lower Division	30	1.40
Upper Division	30	1.90
Classrooms (All levels)	15	0.67
Humanities		
Art		
Lower Division	65	3.05
Upper Division	65	4.05
All Other Humanities		
Lower Division	40	1.90
Upper Division	40	2.50
Professions (UC & CSU)		
Business Administration		
Lower Division	30	1.40
Upper Division	30	1.90
Education		
Lower Division	---	----
Upper Division	40	2.50
Home Economics		
Lower Division	60	2.80
Upper Division	60	3.75
Journalism		
Lower Division	60	2.80
Upper Division	60	3.75
Health Sciences		
Lower Division	---	----
Upper Division	50	3.15

Source: Coordinating Council for Higher Education, 1966, p. 8.

percent (a 10 percent increase), Berkeley's entitlement in just that one category was reduced by 1,669.8 assignable square feet. With building costs in the sciences currently running at about $315 per assignable square foot, the difference in cost is over $500,000. In 1984-85, Berkeley reported a total of 292,050 student credit hours at just the undergraduate level -- a total that created a space entitlement of 486,986.5 assignable square feet in classrooms and teaching laboratories based on the legislative standards approved in 1970 and 1973. If the Coordinating Council's standards shown above in Displays 5 and 6 were used instead, Berkeley's additional entitlement would be approximately 80,000 assignable square feet, and the cost difference, at $300 per assignable square foot, would be $24,000,000. This is a very rough approximation designed only to illustrate the effect of loosening or tightening standards, but it is clear that even relatively slight alterations in the standards can have dramatic effects on appropriations.

This is undoubtedly one reason why space and utilization standards have been debated with such intensity over the years. The other is the fact that there is virtually no empirical basis for determining what the standards should be. Arguably, only the faculty know how much space is really needed for a particular kind of activity, but at the State level, there has always been a suspicion that faculty will judge their needs on the basis of maximum desires rather than minimal requirements. The difference between the two perceptions constitutes the grounds for negotiation.

Other standards are based only on a space allocation since there is no way to determine a utilization standard. Examples are faculty offices and research laboratories. For the former, the only analysis that has ever been performed in California was the 1955 Restudy, which proposed the standards shown in Display 7 on page 16. They can be compared to those listed in the University of California's September 1985 *Instruction and Research Space Summary Analysis*, as shown in Display 8 on page 17.

Display 8 includes a total of 34 different disciplines, yet the Restudy only established specific standards for twelve. As the University has applied the 1955 standards, some disciplines quite clearly have fallen within fairly obvious categories (such as Letters and Interdisciplinary Studies within the Social Sciences), but others have not -- including environment studies, anthropology, social ecology, geography, and information and computer science. Some of these disciplines simply did not exist as distinct fields in 1955 when the Restudy standards were established, and the University has therefore found it necessary to work out new guidelines, often a task which has been accomplished through negotiation with the Department of Finance. The same situation has obviously obtained in the State University as well, and probably in the Community Colleges.

Challenges of categorization and aggregation

Two of the major challenges that will confront the State in its forthcoming study of space and utilization guidelines will be first, to determine which categories of space should be included within a standard or guideline, and second, to decide on an appropriate level of aggregation for certain disciplines. As an example of this second challenge, where a single standard exists today for engineering, it is virtually certain that future guidelines will have to recognize different subdisciplines and levels of engineering instruction. Petroleum engineering, for example, ordinarily has greater space needs than electrical engineering. Within the physical sciences, the space requirements for organic chemistry are much greater than those for theoretical physics, and within the biological sciences, microbiology usually requires more space than botany. Making determinations for these space categories is usually a long and difficult process, since virtually all involve judgments about degrees of difference among subdisciplines. The challenge is to construct a system simple enough to administer yet comprehensive enough to permit the recognition of genuine needs. A few states -- but unfortunately only a few -- have faced this problem, recognized the differences that seemed important to them, and made some interesting decisions about them. Several of these are discussed in detail in Chapter Three.

In addition, many types of space at the University of California at least, currently fall under no standard at all. In its *Instruction and Research Space Summary Analysis*, the University indicates the amount of space on each of its nine campuses to which a standard applies and that with no applicable standard. These are shown by campus in Display 9 on page 18.

From Display 9, it can be seen that over three fourths of the University's total assignable square

DISPLAY 7 Recommended Standard Staff Floor Areas for Instructional Departments at the California State Colleges and the University of California

General Subject Field	State Colleges (Net Square Feet) Offices		University of California (Net Square Feet)			Departmental Shops, Storage, and Miscellaneous[b] (Percent)	
	Academic	Administrative[c]	Research Laboratories[a]	Offices Academic	Offices Administrative[c]	State Colleges	University of California
1	2	3	4	5	6	7	8
Agriculture	110	40	300	140	60	6	10
Arts and Crafts	110	25	100	140	30	6	10
Engineering	110	40	300	160	60	9	15
Languages and Literature	110	25	40	130	30	3	5
Mathematics	110	25	60	130	30	3	5
Miscellaneous Professions[d]	110	50	80	160	80	6	10
Biological Sciences	110	35	250	120	50	6	10
Physical Sciences	110	35	250	120	50	6	10
Social Sciences	110	25	40	130	30	3	5

a. Including research laboratory service rooms (including animal quarters in regular academic buildings), libraries and other collections within the instructional department, and academic conference rooms.

b. Manufacturing and maintenance shops within the instructional department. (Instructional shops are classified as teaching laboratories and are included in Table 33 (See the previous page).

c. Including administrative conference rooms.

d. Education, Journalism, Law, Librarianship, and Social Welfare.

Note: Columns 2-6: Net square feet per full-time-equivalent faculty member (and equivalent ranks) and teaching assistant.

Columns 7-8: Percent of total instructional and staff space, to be added to the sum of the areas obtained from Table 33 and Columns 2-6 above. (Does not include buildings and grounds maintenance shops and storage.)

Source: McConnell, Holy, and Semans, 1955, p. 345, Table 33.

DISPLAY 8 *Comparison of Standard Staff Floor Areas for Instructional Departments as Recommended by the 1955 Restudy and as Implemented in the University of California's Space Summary Analysis.*

General Subject Field (Disciplines with specific study standards shown in sold)	University of California (Net Square Feet)			
	Faculty Research Laboratories[a] (Restudy/UC)	Offices		Departmental Shops,[b] Storage, and Miscellaneous
		Academic (Restudy/UC)	Administrative[c] (Restudy/UC)	Percent (Restudy/UC)
Agriculture	300/300	140/140	60/60	10/10
Agricultural Social Sciences	N/A/53	N/A/140	N/A/47	N/A/6.7
Agriculrtural Economics	N/A/53	N/A/140	N/A/47	N/A/6.7
Agricultural Biological Sciences	N/A/275	N/A/130	N/A/55	N/A/10
Arts and Crafts	100/N/A	140/N/A	30/N/A	10/N/A
Visual Arts	N/A/100	N/A/140	N/A/30	N/A/10
Performing Arts	N/A/100	N/A/140	N/A/30	N/A/10
Engineering	300/300	160/160	60/60	15/15
Agricultural Engineering	N/A/500	N/A/160	N/A/60	N/A/15
Chemical Engineering	N/A/275	N/A/140	N/A/55	N/A/12.5
Information & Computer Science	N/A/180	N/A/145	N/A/45	N/A/10
Language and Literature	40/40	130/130	30/30	5/5
Mathematics	60/60	130/130	30/30	5/5
Miscellaneous Professions[d]	80	160	80	10
Education	80/80	160/160	80/80	10/10
Journalism	80/80	160/160	80/80	10/10
Law	80/80	160/160	80/80	10/10
Library Science	80/80	160/160	80/80	10/10
Social Welfare	N/A/40	N/A/130	N/A/30	N/A/5
Business Administration	N/A/53	N/A/140	N/A/47	N/A/6.7
Administration	N/A/53	N/A/140	N/A/47	N/A/6.7
Environmental Design	N/A/100	N/A/140	N/A/30	N/A/10
Biological Sciences	250/250	120/120	50/50	10/10
Physical Sciences	250/250	120/120	50/50	10/10
Social Sciences	40/40	130/130	30/30	5/5
Letters	N/A/40	N/A/130	N/A/30	N/A/5
Humanities	N/A/40	N/A/130	N/A/30	N/A/5
Interdisciplinary Studies	N/A/40	N/A/130	N/A/30	N/A/5
Environmental Studies	N/A/187	N/A/125	N/A/45	N/A/10
Anthropology	N/A/145	N/A/125	N/A/40	N/A/7.5
Psychology	N/A/145	N/A/125	N/A/40	N/A/7.5
Social Ecology	N/A/145	N/A/125	N/A/40	N/A/7.5
Applied Behavioral Sciences	N/A/100	N/A/130	N/A/40	N/A/10
Geography	N/A/145	N/A/125	N/A/40	N/A/7.5

a. Including research laboratory service rooms (including animal quarters in regular academic buildings), libraries and other collections within the instructional department, and academic conference rooms.

b. Manufacturing and maintenance shops within the instructional department. (Instructional shops are classified as teaching laboratories and are included in Table 33 (See the previous page).

c. Including administrative conference rooms.

d. Education, Journalism, Law, Librarianship, and Social Welfare.

Source: McConnell, Holy, and Semans, 1955, p. 345.

DISPLAY 9 *Assignable Square Feet (ASF) of the University of California's Instruction and Research Facilities Covered or Not Covered by 1955 Restudy or 1966 Coordinating Council Space Standards in 1984-85.*

Campus	ASF Covered by Space Standards		ASF Not Covered by Space Standards		Total Campus ASF Reported
	Number	Percent	Number	Percent	
Berkeley	2,171,258	31.0	4,824,556	69.0	6,995,814
Davis	1,226,631	23.1	4,079,398	76.9	5,306,029
Irvine	528,046	17.9	2,416,353	82.1	2,944,399
Los Angeles	1,854,977	24.2	5,818,810	75.8	7,673,787
Riverside	532,889	28.3	1,347,120	71.7	1,880,009
San Diego	591,455	17.5	3,382,833	82.5	3,974,288
Santa Barbara	804,482	30.1	1,868,984	69.9	2,673,466
Santa Cruz	320,871	19.3	1,337,440	80.7	1,658,311
Totals	8,030,609	24.3	25,075,494	75.7	33,106,103

Source: University of California, 1985.

feet are not subject to any space standard. To provide an indication of the types of space that have never been standardized, a sample of non-standard facility categories applicable to the Berkeley campus are listed below. Most, but not all, of these spaces were constructed with non-State funds.

All Institutes
Associated Students Facilities
Botanical Gardens
California Alumni Association
Campus Police Facilities
Computer Centers
Cooperative Extension
Greenhouses
Faculty Club
Intercollegiate Athletics Offices
Language Laboratories
Lawrence Berkeley Laboratory
Military Science
Museums
Optometry
Physical Education
Public Health
Residence Halls
Seismology Stations
Summer Session Offices
University Extension
University of California Press

Concerning utilization of classrooms and teaching laboratories, only the California State University undertakes an annual survey that lists the number of rooms of each type, the number of student stations, mean room size, mean class size, weekly room hours of use, station occupancy percentages, and weekly student hours per station. The last of these statistics is the most important, since it is the one number that is applied to the space standard to produce overall square footage allotments. Display 10 on the opposite page shows the station occupancy figures for each State University campus as of Fall 1983.

As can be seen, only one of the 19 campuses (San Luis Obispo) meets the Legislature's classroom utilization rate, but seven exceed its lower-division

DISPLAY 10 California State University Utilization Rates for Classrooms and Laboratories, Fall 1983 (Numbers in Bold are for Those Meeting or Exceeding the Standards)

Campus	Classrooms (Legislative Standard = 35.5 Hrs./Wk)	Lower Division Laboratories (Legislative Standard = 23.4 Hrs/Wk)	Upper Division Laboratories (Legislative Standard = 17.6 Hrs/Wk)
Bakersfield	22.330	9.169	**19.692**
Chico	32.744	23.057	**19.012**
Dominguez Hills	26.511	8.991	13.031
Fresno	32.637	19.646	17.420
Fullerton	30.047	**25.628**	**22.696**
Hayward	25.283	11.505	11.831
Humboldt	26.081	**23.868**	**18.851**
Long Beach	32.656	**26.969**	**23.214**
Los Angeles	20.642	14.759	12.765
Northridge	32.562	**27.732**	**25.471**
Pomona	34.762	21.526	**22.834**
Sacramento	31.476	**28.698**	**22.723**
San Bernardino	26.491	18.761	15.149
San Diego	32.303	**24.779**	**17.667**
San Francisco	30.356	18.423	**20.210**
San Jose	27.332	**27.603**	**18.230**
San Luis Obispo	**35.681**	21.787	**20.404**
Sonoma	19.533	14.134	16.662
Stanislaus	23.602	13.662	16.526
All Campuses:			
Mean	29.651[1]	22.036[2]	**19.328**[3]
Standard Deviation	4.822	6.425	3.805

1. 83.5 percent of the legislative standard.
2. 94.2 percent of the legislative standard.
3. 109.8 percent of the legislative standard.

Source: California State University, 1985.

laboratory utilization rate and 12 exceed its upper-division laboratory utilization rate.

Conclusion

It may be obvious from this review of the mechanics of space and utilization standards that it is virtually impossible to create viable standards for instructional and research areas without considering both the square footage of a given student or faculty station (the space standard) and the frequency of its use (the utilization standard). Relatively minor changes in either standard can have dramatic effects on the total space allotment for any campus, yet there is no set of hard and fast rules, or any comprehensive body of data that can clearly and unarguably indicate what the standards should be. Virtually all standards that have been created since the

Liaison Committee's 1948 report have been judgments and estimates based on as much experience as could be brought to bear on the problem at the time. Over the years, they have been changed and changed again, sometimes increased in stringency and sometimes relaxed, but never set in a place, or at a level, that elicited wide agreement. In the past, most standards have produced far more controversy than consensus.

At the present time, consensus appears to be as elusive as ever, and it is primarily because of that fact that the Legislature has requested this report. It is abundantly clear that the segments -- and particularly the University of California -- believe that the space standards against which many of their capital outlay requests in engineering and the sciences are being measured are seriously out of date. It is also clear that none of the segments has ever agreed with the utilization standards approved by the Legislature through resolutions and supplemental budget language in the early 1970s. Nonetheless, while no utilization data are available as yet from the University of California, the comprehensive data supplied by the State University on classroom and laboratory utilization provide at least a general indication of the viability of these standards.

3 *Space and Utilization Standards in Other States*

FOR this report, the Commission was able to collect detailed data on space and utilization standards from 13 states and indirect information on 12 others, based on a recent survey by the Nebraska Coordinating Commission for Postsecondary Education. In all probability, most of the remaining 24 states do not have detailed space and utilization standards but employ an informal process involving negotiations between the campuses and state-level fiscal agencies on specific projects. But because the Nebraska survey produced responses from only 17 of these states, the California Postsecondary Education Commission will conduct another national survey in the second phase of its study.

Among the 13 states that submitted documents for this report, three levels of sophistication are evident:

1. Alabama, Alaska, Kansas, Illinois, Louisiana, and South Carolina report utilization data and occasionally a few space standards, while Texas and Virginia report comprehensive space standards but no utilization data;
2. Nebraska, North Carolina, and Ohio report both utilization data and space standards for classrooms and teaching laboratories; and
3. Florida and New York provide utilization data and space standards for classrooms, teaching laboratories, and research laboratories.

Louisiana's utilization report is so cumbersome that it proved to be unusable for the purposes of this report, but the data and procedures used by each of the remaining 12 states are described in this chapter, with the states listed in terms of these three levels of complexity.

Alabama

The Alabama Commission on Higher Education produced a report in February 1982 (based on Fall 1980 data) entitled *Facilities Inventory and Space Utilization Report*. Alabama has no formal standards but operates with what it calls "generally accepted criteria." For classrooms, these are a range of between 25 and 30 hours per week with between 60 and 70 percent station occupancy. For teaching laboratories, the ranges are between 14 and 18 hours per week at 55 to 65 percent occupancy for upper-division courses and between 22 and 26 hours per week at 75 to 85 percent occupancy for lower-division courses. Also indicated are "space factors" for assignable square feet per weekly student contact hour, even though no standards for assignable square feet per station are listed in the report. Based on those standards, the six largest Alabama institutions reported the utilization data shown in Display 11 on page 22.

Two things are evident from the Alabama data:

- First, the utilization standards, or "ranges" as they are called, are quite low by other states' standards, as will soon be demonstrated as this review proceeds.
- Second, Alabama's institutions are not, in general, meeting even those standards.

In comparing Alabama's data to the utilization data and space factors at the California State University, it is clear that the State University is using its facilities at a far greater rate than Alabama's institutions. The key statistic is hours of station occupancy, and on this measure, the State University's classroom usage is more than twice that of Alabama's; while for laboratories, it is between 48.5 and 69.2 percent higher.

Alaska

In December 1983, the Alaska Commission on Postsecondary Education published *Instructional Space Utilization at the University of Alaska*, which presented data in three volumes for the 13 institutions that comprise the University of Alaska system. It included no space standards, but its utilization standards were that classrooms should be used 30 hours per week at 60 percent occupancy; laboratories

DISPLAY 11 Classroom and Teaching Laboratory Utilization and Space Factors at the Six Largest Institutions of Higher Education in Alabama, Fall 1980, Compared to Similar Factors at the California State University, Fall 1983

Institution	Hours of Room Utilization per Week	Percent Station Occupancy	Hours of Station Occupancy per Week	Space Factor (ASF/WSCH)
Alabama A & M				
Classrooms	28.6	46	13.2	1.39
Laboratories	18.6	70	13.0	3.76
Alabama State University				
Classrooms	21.2	50	10.6	1.57
Laboratories	16.2	46	7.5	4.57
Auburn University				
Classrooms	24.8	61	15 1	0.87
Laboratories	17.5	63	11.0	3.97
Jacksonville State University				
Classrooms	14.0	65	9.1	1.94
Laboratories	5.9	91	5.4	5.14
University of Alabama				
Classrooms	23.0	58	13.3	1.19
Laboratories	14.5	66	9.6	5.40
University of Alabama - Birmingham	29.7	58	17.2	0.90
Classrooms	18.1	72	13.0	3.35
Laboratories				
Average for All Alabama Senior Institutions				
Classrooms	23.5	59	13.9	1.19
Laboratories	18.1	72	13.0	3.35
Average for the California State University				
Classrooms	41.8	71.0	29.7	0.43[1]
Laboratories				
Lower-Division	23.6	93.3	22.0	-.--[2]
Upper-Division	20.7	93.2	19.3	-.--[2]

1. Current legislative standard.
2. Variable depending on the space factors for various disciplines.

Source: Alabama Commission on Higher Education, 1982, pp. 19-22, and California State University, 1985.

for 20 hours per week at 80 percent occupancy -- standards identical to those suggested in California's *Master Plan for Higher Education* in 1960. The Alaska Commission did not indicate the length of the day these standards are to be applied to, but it must be presumed to be 8:00 a.m. to 5:00 p.m. unless otherwise indicated, since those hours have long been used nationally for measuring the school day.

Display 12 compares the actual classroom and teaching laboratory utilization experience at the three general campuses of the University of Alaska as of Fall 1982. It indicates that the State University's utilization patterns are far higher than in Alaska for all campuses and all categories.

DISPLAY 12 Classroom and Laboratory Utilization at the University of Alaska, Fall 1982, Compared to that of the California State University, Fall 1983[1]

Institution and Type of Facility	Hours of Room Utilization (Credit Courses)	Percent Station Utilization (Credit Courses)	Hours of StationUtilization (Credit Courses)
Anchorage Campus			
Classrooms	36.7	54.0	19.8
Laboratories	13.8	74.0	10.2
Fairbanks Campus			
Classrooms	31.5	59.0	18.6
Laboratories	15.2	76.0	11.6
Juneau Campus			
Classrooms	17.1	47.0	8.0
Laboratories	20.4	75.0	15.3
Average for the California State University			
Classrooms	41.8	71.0	29.7
Laboratories			
Lower Division	23.6	93.3	22.0
Upper Division	20.7	93.2	19.3

1. Based on utilization standards of 30 hours per week with 60 percent utilization for classrooms and 20 hours per week with 80 percent utilization for laboratories.

Source: Alaska Commission on Postsecondary Education, 1983, pp. 7-23, and California State University, 1985.

Kansas

The most recent report available from Kansas is its Board of Regents' *Report of Physical Facilities and Space Utilization at Selected Postsecondary Institutions for Fall, 1975*. It shows no space or utilization standards, but does present data on the number of hours each classroom and laboratory is used each week. Unfortunately, the report does not indicate a percentage of station occupancy or weekly hours of station occupancy, and it is therefore not possible to compare California and Kansas station occupancy rates. Nevertheless, for classrooms in the seven public four-year institutions in Kansas, hours of weekly room use vary between 21.9 and 37.0. This number compares to California's 53.0 hour standard and the State University's 41.8 hour actual usage. For laboratories, Kansas' colleges and universities range between 13.0 and 22.6 hours of use per week. California's standard is between 22.0 and 27.5; the State University's actual usage is between 20.7 and 23.6.

Illinois

The Illinois' Board of Higher Education's 1983 space and utilization survey lists no space standards and offers only limited data on utilization of classrooms and laboratories. Similar in format to the Kansas report mentioned above, it shows a range of weekly room-hour use but no percentage figures for occupancy and, therefore, no figures for hours of weekly station occupancy. The utilization ranges for classrooms at Illinois' 13 public institutions are 21.7 to 46.7, with an average of 29.2 based on a 7 a.m. to 10

p.m. day. For laboratories, the range is from 8.6 to 21.2, with an average of 14.3. As with Kansas, this compares to the California standards of 53.0 hours for classrooms and between 22.0 and 27.5 for laboratories.

South Carolina

South Carolina's Commission on Higher Education has reported not only useful utilization data on classrooms and laboratories for 1983 and 1984 but also a group of basic utilization "guidelines." It presents these guidelines not as hard and fast standards but as suggestions with a relatively low standard listed as "acceptable" and a slightly higher one as "desirable." Displays 13 and 14 on pages 25-26 present these guidelines for classrooms and laboratories respectively and the results of its survey. These displays also compare the data to California's standards.

Displays 13 and 14 demonstrate that South Carolina's institutions of higher education are barely meeting the minimum "acceptable" requirements established by the South Carolina Commission on Higher Education for classrooms and are about 25 to 30 percent below the "desirable" standards. For laboratories, the institutions are considerably below even the minimally acceptable standards and very far away from those thought to be desirable (about 45 to 50 percent). South Carolina's desirable standards are close to those recommended in 1966 by the Coordinating Council, but they are somewhat below those approved by the Legislature in 1973. Comparing South Carolina's utilization data to those reported by the State University for Fall 1983 indicates that the State University is using both its classrooms and laboratories at rates of about twice those of South Carolina's institutions.

Nebraska

Nebraska's Coordinating Commission for Postsecondary Education conducted a national survey in 1981 in which it was able to collect both space and utilization standards from 15 other states. Its 1981 report on this survey offered data and standards on utilization but no space standards.

Nebraska's utilization standards are in the average-to-low range for the nation, calling for classroom usage of 30 hours per week at 60 percent station occupancy and laboratory usage of 20 hours per week at 80 percent station occupancy. The Nebraska Commission presents only classroom hourly use in its report, neglecting to add station occupancy percentages. These data from Nebraska's four-year institutions appear in Displays 15 and 16 on page 27.

As with other states previously mentioned, Nebraska's actual utilization is considerably lower than its standard, averaging 25.77 hours per week on an 8 a.m. to 5 p.m. basis for classrooms, and 15.08 hours for laboratories. These utilization rates are 14.1 and 24.6 percent below its standard.

The data gathered by the Nebraska Commission from other states present no actual utilization data but offer helpful information, not only about utilization and space standards for classrooms but also for a variety of teaching laboratories. These are shown in Displays 17 and 18 on pages 28-29. In some cases, no data for room hours or station occupancy are offered, but space factors are listed, and since California uses a space factor (assignable square feet per weekly student contact hour), comparisons with the other states are possible. In California's case, the classroom utilization standard is 53 hours of room use at 66 percent station occupancy with a space allowance of 15 assignable square feet per station. By California's formula shown on page 14 of Chapter Two, California's classroom space factor is therefore .43 assignable square feet per weekly student contact hour. The last column of Display 17 compares this factor to those of 15 other states.

The average hours of expected classroom use in the eleven states whose standards are listed in Display 17 is 33.4, with eight of the 11 using 30 hours as their standard. Only Oklahoma constitutes an anomaly in this regard in that it reports a standard of 60, the only standard among the 11 higher than California's. Concerning expected station occupancy, there is greater similarity, with the same 11 states reporting an average of 64.6, compared to California's 66. For space factors, however, there is also a wide discrepancy. Compared to California's .43, the 13 states reporting factors averaged .78, a figure 82.3 percent more liberal than in California. Most of these states allow slightly more assignable square feet per station than California.

Teaching laboratory standards in the other states are somewhat closer to California's practice, as shown in Display 18. The 11-state average for utilization is 24.5 room hours at 78.2 percent station occupancy, compared to a California average of 24.75

DISPLAY 13 *Daytime Classroom Utilization Rates and Guidelines at South Carolina Institutions of Higher Education (8 a.m. to 5 p.m.), Compared to California Standards*

Institution	Number of Hours of Weekly Room Usage (8:00 a.m. to 5:00 p.m.)		Station Occupancy Percentage		Number of Hours of Weekly Station Occupancy	
	1984	1983	1984	1983	1984	1983
Clemson University	24	23	64	63	15	15
University of South Carolina - Columbia	26	25	59	58	15	15
The Citadel	16	15	71	72	11	11
College of Charleston	28	24	63	61	18	15
Francis Marion College	21	21	63	60	13	13
Lander College	20	18	62	65	12	12
South Carolina State College	27	25	62	64	17	16
University of South Carolina						
Aiken	28	27	51	51	14	14
Coastal Carolina	27	24	64	64	17	15
Spartanburg	24	22	58	58	14	13
Winthrop College	27	26	61	64	17	17
Unweighted Average	24	23	62	62	15	14
South Carolina Commission on Higher Education Guidelines:						
Acceptable	27	27	55	55	14.9	14.9
Desirable	31.5	31.5	65	65	20.5	20.5
California Standards						
8 a.m. to 10 p.m.	53	53	67	67	35.5	35.5

Source: South Carolina Commission on Higher Education, 1985, p. 3. and Coordinating Council for Higher Education, 1966, as modified by the California Legislature in 1970.

DISPLAY 14 *Daytime Laboratory Utilization Rates and Guidelines at South Carolina Institutions of Higher Education (8 a.m. to 5 p.m.), Compared to California Standards.*

Institution	Number of Hours of Weekly Room Usage (8:00 a.m. to 5:00 p.m.)		Station Occupancy Percentage		Number of Hours of Weekly Station Occupancy	
	1984	1983	1984	1983	1984	1983
Clemson University	18	17	78	80	14	14
University of South Carolina - Columbia	14	14	62	64	9	9
The Citadel	11	10	66	61	7	6
College of Charleston	20	13	73	54	15	7
Francis Marion College	12	11	77	74	9	8
Lander College	11[1]	18	73	59	8[1]	11
South Carolina State College	18	14	78	84	14	12
University of South Carolina						
Aiken	16	16	65	67	10	11
Coastal Carolina	13	13	64	73	8	9
Spartanburg	16	13	59	73	9	9
Winthrop College	13	10	63	70	8	7
Unweighted Average	15	14	63	69	9	10
South Carolina Commission on Higher Education Guidelines:						
Acceptable	18	18	70	70	13	13
Desirable	22.5	22.5	80	80	18	18
California Standards						
Lower-Division	27.5	27.5	85	85	23.4	23.4
Upper-Division	22.0	22.0	80	80	17.6	17.6

1. Report notes that "decrease due to change in way labs are counted."

Source: South Carolina Commission on Higher Education, 1985, p. 5, and Coordinating Council for Higher Education, 1966, as modified by the California Legislature in 1973.

DISPLAY 15 Number of Classrooms Scheduled per Week at Nebraska Colleges and Universities

Institution/Campus	Number of Scheduled Classes	Number of Hours Scheduled: 8:00 a.m. to 5:00 p.m. Monday through Friday	Number of Hours Scheduled: Other[1]	Number of Hours Scheduled: Total	Average Number of Hours Each Room is Scheduled Per Week
State Colleges					
Chadron	47	677.0	49.0	726.0	15.45
Kearney	84	2,007.0	219.0	2,226.0	26.50
Peru	24	344.0	11.0	355.0	14.79
Wayne	36	710.7	71.5	782.0	21.70
Total	191	3,738.5	350.5	4,089.0	21.41
University of Nebraska					
Curtis	14	307.0	--	307.0	21.93
Lincoln	279	7,078.5	--	7,078.5	25.37
Omaha	91	2,475.0	867.0	3,342.0	36.73
Total	384	9,860.5	867.0	10,727.5	27.94
Total/Average	575	13,599.0	1,217.5	14,816.5	25.77
Nebraska Utilization Standard					30.00 @ 60%

1. "Other" is not defined in the report. Presumably it refers to scheduled evening and weekend hours.

Source: Nebraska Coordinating Commission for Postsecondary Education, 1981, p. 12.

DISPLAY 16 Number of Class Laboratories Scheduled per Week at Nebraska Colleges and Universities

Institution/Campus	Number of Scheduled Class Laboratories	Number of Hours Scheduled: 8:00 a.m. to 5:00 p.m. Monday through Friday	Number of Hours Scheduled: Other[1]	Number of Hours Scheduled: Total	Average Number of Hours Each Room is Scheduled Per Week
State Colleges:					
Chadron	29	270.0	--	270.0	9.31
Kearney	41	565.0	37	602.0	14.68
Peru	16	170.0	5	175.0	10.94
Wayne	34	384.5	9	393.5	11.57
Total	120	1,389.5	51	1,440.5	12.00
University of Nebraska					
Curtis	13	278.0	--	278.0	21.38
Lincoln	158	2,444.5	--	2,444.5	15.47
Omaha	37	628.0	154	782.0	21.14
Total	208	3,350.5	154	3,504.5	16.85
Total/Average	328	4,740.0	205	4,945.0	15.08
Nebraska Laboratory Standard					20.00 @ 80%

1. "Other" is not defined in the report. Presumably it refers to scheduled evening and weekend hours.

Source: Nebraska Coordinating Commission for Postsecondary Education, 1981, p. 12.

DISPLAY 17 Classroom Space Standards in Sixteen States

State	Room Hours per Week	Percent Station Occupancy	ASF per Student Station	Space Factor[1]
Alabama	30	50 to 70	None[2]	Classroom Space = Area per Station x WSH/AvRUR x AvSOR[3]
Colorado	30	67	15	.75
Indiana	N/A	N/A	N/A	Purdue University: .54 Indiana University: .66 Indiana State University: .95 Ball State University: .75
Kansas	N/A	N/A	N/A	.833 NASF per activity load unit.
Massachusetts	N/A	N/A	N/A	135 ASF per student in total. 30 ASF in classrooms.
Montana	N/A	N/A	N/A	.83 ASF/WSH
New Jersey	34	70	16	.67 NASF/SCH
New Mexico	30	60	16	.89
New York	Classrooms: 30 Lecture Halls: 20	60	Classrooms: 16 Lecture Halls: 12	Classrooms: .89 Lecture Halls: 1.00
North Carolina	30	60	16	.89
Oklahoma	60	80	16	.33
Oregon	33	60	15	.76
Texas	30	66.6	16.5	.825
Washington	30	60	18	1.00
Wisconsin	30	67	16	.80
California	**53**	**66**	**15**	**.43**

1. Space Factor is a measure of assignable square feet per weekly student contact or credit hour, variously referred to as WSCH, WSH, or WCH.
2. AvRUR: Average room utilization rate. AvSOR: Average station occupancy rate.
3. No official standard: Allocation geared to institutional average.

Source: Nebraska Coordinating Commission for Postsecondary Education, 1981, p. 28

DISPLAY 18 Laboratory Space Standards in Fourteen States

State	Room Hours per Week	Percent Station Occupancy	ASF per Student Station	Space Factor[1]
Alabama	20	70	25-175 Agriculture 65 Education 40 Business 30 Humanities 30 Sciences 75	Classroom Space = Area per station x WSH/AvRUR x AvSOR[2]
Colorado	30	80	18.8-177.0 Agriculture 52 Business 33 Sciences 55	1.18 to 14.75
Massachusetts	N/A	N/A	N/A	135 ASF per student in total; 20 ASF in classrooms.
Montana	N/A	N/A	N/A	1.88 to 11.52 Agriculture 4.38 (LD); 7.19 (UD) Business 2.19 Education 2.81 Engineering 7.50 (LD); 11.25 (UD) Physical Science 3.75 (LD); 5.62 (UD)
New Jersey	24	80	30 to 110 Agriculture 60 Business 30 Education 30 Engineering 100 Physical Science 60	1.56 to 5.73 Agriculture 3.12 Business 1.56 Education 1.56 Engineering 5.21 Physical Science 3.12
New Mexico	20	80	Engineering 100	6.25
New York	24	80	40 to 160 Agriculture 160 Business 40 Education 40 Engineering 65-160 Physical Science 68	2.08 to 8.33 Agriculture 8.33 Business 2.08 Education 2.08 Engineering 3.38 to 8.33 Physical Science 3.54
North Carolina	20	80	Academic 40 Engineering/Mech. 100	Academic 2.50 Engineering/Mechanical 6.25
Oklahoma	48	80	Life Sciences 75 Math, Computer, Physical and Engineering Sciences 144 Behavioral Science 60 Humanities 48 Professions 48	Life Science 1.95 Mathematics, Computer, Physical, and Engineering Sciences 3.75 Behavioral Sciences 1.56 Humanities 1.25 Professions 1.25
Oregon	LD 22 UD 16	LD 80 UD 60	Agriculture 160 Business 32 Engineering 110-160 Physical Sciences 65	N/A
Texas	20	80	Agriculture 80 Business 32 Engineering 100 Physical Sciences 50	N/A
Washington	20	80	25-175	1.56-10.93
Wisconsin	24	80	Average Laboratory Station Size: 71.5	Average Laboratory Space Factor: 3.72
California				
Lower Division	27.5	85	Variable by Discipline	Variable by Discipline
Upper Division	17.6	80		

1. Space Factor is a measure of assignable square feet per weekly sstudent contact or credit hour, variously referred to as WSCH, WSH, or WCH.
2. AvRUR: Average room utilization rate. AvSOR: Average student occupancy rate.

Source: Nebraska Coordinating Commission for Postsecondary Education, 1981, p. 30

at 82.5 for upper-division and lower-division instruction combined. If Oklahoma's unusually high standards are excluded, however, the remaining ten states averaged 22.1 hours at 78 percent occupancy with a moderate preference for 20 hours and a strong preference for 80 percent.

Some of these states reported space standards for certain kinds of laboratories, not all of which are comparable to California's. Those applicable to engineering and the sciences are presented in Display 19.

North Carolina

North Carolina uses the same kind of space standards as California, a combination of a space allocation per station combined with a utilization rate consisting of hours of weekly room use multiplied by a station occupancy percentage. For classrooms, North Carolina's space allocation is 16 assignable square feet per station; for laboratories, it varies between 15 and 150 with an average of 40. Its utilization standard calls for classroom usage at 30 hours per week with 60 percent station occupancy; for

DISPLAY 19 Teaching Laboratory Space Factors for Various Disciplines in Eleven States[1]

State	Discipline		
	Sciences	Engineering	Physical Sciences
Alabama	5.36	--	--
Colorado	2.29	--	--
Montana			
Lower Division	--	7.50	3.75
Upper Division	--	11.25	5.62
New Jersey	--	5.21	3.12
New Mexico	--	6.25	--
New York	--	3.38-8.33	3.54
North Carolina	--	6.25	--
Oklahoma	3.75[2]	--	--
Oregon			
Lower Division	--	6.25-9.09	3.69
Upper Division	--	11.46-16.67	6.77
Texas	--	6.25	3.13
Average[3]	3.80	7.15	3.94
California			
Lower Division	--	4.72	1.81
Upper Division	--	2.50	2.63

1. The "space factor" is the number of assignable square feet per station divided by the product of the weekly room hours of usage times the percent of station occupancy (as illustrated by the formula on page 13.)
2. This standard is for mathematics, computer sciences, physical sciences, and engineering.
3. Averages are not strictly comparable due to averaging of ranges and differential standards for lower division/upper division.

Sources: Other states than California: Nebraska Coordinating Commission for Postsecondary Education, 1981, p. 30. California: Coordinating Council for Higher Education, 1966, as modified by the California Legislature in 1973.

laboratories, it is 20 hours per week at 80 percent occupancy. When developing capital outlay budgets, however, North Carolina uses space factors just as California does, and these factors provide for an allocation of .89 assignable square feet per weekly student contact hour for classrooms (compared to .43 in California) and a variable standard for laboratories depending on the number of square feet per station allocated for various disciplines. These are shown in Display 20 with comparisons to the 1966 Coordinating Council space standards.

In the biological sciences, North Carolina's standards are very close to California's at the lower-division level and slightly more generous than California's at the upper-division level. In engineering, North Carolina's standards are so variable and cover so many different subdisciplines that a valid comparison is not possible. In the physical sciences, and with the exception of oceanography, the two states appear to be in close proximity. In spite of that, however, California's standards ultimately emerge as somewhat stricter due to its tighter utilization standards. When those are applied to create the space factor, California generally allows fewer square feet for both classrooms and laboratories than does North Carolina.

DISPLAY 20 North Carolina Class Laboratory Standards by Discipline (Including Service Areas), Compared to California Standards

Discipline		North Carolina ASF/Station	California ASF/Station
Biological Sciences			
Botany, General:	Lower Division	45-55	
	Upper Division	50-70	(All subdisciplines)
Physiology:	Lower Division	50-70	Lower Division - 55
	Upper Division	70-90	Upper Division - 60
Biochemistry:	Lower Division	55-65	
	Upper Division	60-80	
Engineering			
Petroleum (all levels)		150-200	
Civil, Construction, and Transportation			
Soils, Photogrammetry (all levels)		70-80	(All subdisciplines)
Hydraulics, Concrete (all levels)		100-120	Lower Division - 90
Strength of Materials (all levels)		130-180	Upper Division-110
Electrical, Electronics, and Communications			
Measurements, Electronics, and Communications (all levels)		55-65	
Circuits (all levels)		80-90	
Machines, Power (all levels)		100-120	
Physical Sciences			
Physics:	Lower Division	40-50	
	Upper Division	50-80	
Chemistry, General (all levels)		45-55	(All subdisciplines)
Organic Chemistry (all levels)		70-80	Lower Division - 60
Geology:	Lower Division	40-50	UpperDivision - 70
	Upper Division	50-70	
Oceanography:	Lower Division	60-100	
	Upper Division	70-150	

Source: The University of North Carolina. 1984, p.65, and the Western Interstate Commission for Higher Education, 1971, p. 127.

Ohio

Ohio's Board of Regents has published comprehensive data containing both classroom and teaching laboratory standards and its utilization experience (1982). Unlike most states surveyed for this report, Ohio uses differential standards for different size classrooms, as indicated in Display 21 on the opposite page.

Ohio's space standard for regular classrooms is identical to California's -- 15 assignable square feet per station -- but it is lower for lecture halls (12 assignable square feet per station) due to the greater spacial economy inherent in larger facilities, and higher for seminar rooms (20 assignable square feet per station) because of less spacial economy in small rooms. Similarly, Ohio recognizes that lecture halls cannot be used as often as regular classrooms due to the greater amount of time required for setup and takedown, while seminar rooms can be used more often for the opposite reason. Finally, Ohio uses different standards for daytime and evening use of classrooms, establishing a standard of 31.5 hours per week between 8 a.m. and 5 p.m. (70 percent of the total hours available) and 15 hours per week between 5 p.m. and 10 p.m. (60 percent of the available hours). For laboratories, a similar principle applies. During the day, laboratories are to be used 22.5 hours per week with 80 percent station occupancy; in the evening, 15 hours per week with 80 percent occupancy.

Ohio is one of the few states that has established space standards for both teaching and research laboratories. These are shown in Display 22 for engineering and the natural sciences together with the applicable space factors (the combination of the space standard with the utilization standard) and compared to the standards currently in use in California.

It can be observed from Display 22 that while Ohio's space-per-station standards for teaching laboratories are not markedly different from those employed in California, its space factors are. The reason, as in a number of other examples shown in this chapter, is the higher utilization factor required of California institutions. In fact, while California's space-per-station standard for lower-division physical sciences, as an example, is 9.1 percent higher than Ohio's (60 and 55 assignable square feet per station, respectively), California's space factor is actually 20 percent lower once its utilization standard is applied. For research laboratories, Ohio offers a greater amount of working space to faculty members by a factor of between 10 and 33 percent.

Display 23 on page 34 shows actual utilization of classrooms and laboratories in 11 Ohio institutions compared to the Ohio Board of Regents' 8 a.m. to 10 p.m. standards. From it, it is apparent that no Ohio institution is meeting the standards. Bowling Green and Toledo come closest for classrooms with Bowling Green and Wright State the closest for teaching laboratories. As a group, however, the 11 institutions fall 16 percent below the daytime classroom standard and 43 percent below the combined day and evening standard for classrooms; for laboratories, they fall 41 percent below the day standard and 64 percent the day and evening standard combined. In each case, they are far below the utilization record of the California State University, as indicated by Display 11 on page 22.

Texas

The standards of the Coordinating Board, Texas College and University System, are comprehensive for classrooms and teaching laboratories but not especially useful with regard to research laboratories. As a standard for the latter, the Coordinating Board uses a general guideline of 400 assignable square feet per full-time-equivalent faculty member but qualifies the guideline by stating that it "has developed no criteria for identifying those people who require research space and it is necessary that the institution develop a plan, in accord with campus role and mission, for this purpose" (1982, p. D1-21). Its standard of 400 assignable square feet applies to science, agriculture, engineering, home economics, veterinary medicine, and pharmacy. For other disciplines such as psychology, fine arts, law, nursing, and optometry, its standard is only 50 assignable square feet per full-time-equivalent faculty member.

For classrooms, Texas uses a utilization standard of 30 hours per week at 67 percent station occupancy. Its space factors vary greatly according to type but they are similar to Ohio's in concept, although more stringent. They are shown in Display 24 on page 35.

For classrooms of normal size (25 to 70 stations), Texas' standards are more restrictive than California's, allowing about 11 to 15 assignable square feet per station for rooms of that size, compared to California's 15 for all types of classroom space. As the

DISPLAY 21 Ohio Space and Utilization Standards for Classrooms

1. Type of Space	2. ASF/Station	3. Weekly Hours of Room Use	4. Percent Station Occupancy	ASF/WSCH 2 ÷ [3 x 4]
General Classrooms				
Daytime Use	15	31.5	.67	.711
Evening Use	15	15.0[1]	.67	1.492
Lecture Halls	12	27	.67	.663
Seminar Rooms	20	34	.67	.878

1. Based on 23 hours per week of available time. There are 25 hours from 5:00 p.m. to 10:00 p.m., but two are deducted to account for "community service, continuing education, etc.," and 65 percent of that is then taken to produce the 15 hours per week.

Source: Ohio Board of Regents, 1974, pp. 6-7.

DISPLAY 22 Ohio and California ASF/Station Standards for Laboratory Facilities

	Space Factor					
	ASF/Station in Teaching Laboratories		ASF/WSCH in Teaching Laboratories		ASF/Station in Research Laboratories	
Discipline	Ohio	California	Ohio	California	Ohio	California
Biological Sciences					275	250
Lower Division	60	55	3.33	2.35		
Upper Division	75	60	4.17	3.41		
Physical Sciences					275	250
Lower Division	55	60	3.06	2.56		
Upper Division	70	70	3.89	3.98		
Engineering Sciences						300
Architectural, Bioengineering, and Engineering Physics	70		3.89		N/A	
General Engineering, Electrical, and Geophysical	100		5.56		350	
Agricultural, Chemical, Civil, Metallurgical, Ceramic, Textile, and Environmental	120		6.67		350/375	
Aeronautical, Petroleum, Geological, Materials, Mining, Nuclear, Naval Architecture, Ocean, and Engineering Technology	140		7.78		400	
Mechanical, Industrial, and Engineering Mechanics	150		8.33		300/350	
Lower Division	N/A	90		3.84		
Upper Division	N/A	110		6.25		

Source: Ohio Board of Regents, 1974, pp. 9-12, and California: Coordinating Council for Higher Education, 1966, as modified by the California Legislature in 1973.

DISPLAY 23 *Ohio Station Utilization in Classrooms and Teaching Laboratories Compared to the Ohio Standards*

Ohio Universities	Ohio Station Utilization in Classrooms (8:00 a.m. to 10:00 p.m.)	Ohio Station Utilization in Laboratories (8:00 a.m. to 10:00 p.m.)
University of Akron	22.8	14.6
Bowling Green University	25.1	13.5
University of Cincinnati	15.5	9.6
Cleveland State University	20.4	7.8
Kent State University	12.7	10.1
Miami University	15.0	9.1
Ohio State University	16.8	12.6
Ohio University	13.3	6.1
University of Toledo	27.3	10.3
Wright State University	21.1	17.0
Youngstown State University	20.7	8.8
Weighted average by number of stations	17.8	10.7
Ohio Standards: Classrooms		
Day	21.1	
Evening	10.1	
Total Classrooms	31.2	
Lecture Halls	18.1	
Seminar Rooms	22.8	
Laboratories		
Day		18.0
Evening		12.0
Total Laboratories		30.0

Source: Ohio Board of Regents, 1974 and 1982.

rooms increase in size, Texas tends to shrink the standard until it reaches a low, including circulation space, of 8.2 assignable square feet per station for lecture halls over 1,000 stations.

For teaching laboratories, Texas' standards are as diverse and comprehensive as any in the nation. They are summarized in Display 25 on page 36, and although this display appears to be exceedingly complex, it is in reality only a summary of a series of tables presented in the Texas report. Each of the major discipline categories actually contains further subdivisions for certain kinds of specialties. To decipher Display 25 somewhat, it indicates that Texas' standards are either close to or more restrictive than California's at the undergraduate level but somewhat more ample at the graduate level. However, as is true elsewhere, once the utilization standards are applied to produce the space factor, California's

DISPLAY 24 Texas Classroom Space Allowances

Type of Space and Number of Stations	ASF per Station	ASF Required for Circulation	Total ASF per Room	Net ASF per Station
1. Tablet Armchairs, Two Aisles, No Rear Aisle				
16-25	8	190	320-390	15.6-20.0
26-35	8	195	390-475	13.6-15.0
36-45	8	200	475-560	12.4-13.2
46-55	8	205	560-645	11.7-12.2
56-70	8	210	645-770	11.0-11.5
71-90	8	220	770-940	10.4-10.9
2. Tablet Armchairs, Three Aisles, One Rear Aisle				
91-125	8	470	1,200-1,470	11.8-13.2
126-175	8	495	1,470-1,895	10.8-11.7
176-225	8	520	1,895-2,320	10.3-10.8
3. Rows of Tables and Chairs, Two Aisles				
16-25	12	250	440-550	22.0-27.5
26-35	12	260	550-680	19.4-21.2
36-45	12	270	680-810	18.0-18.9
46-55	12	280	810-940	17.1-17.6
4. Lecture Auditoriums				
176-225	8	520	1,895-2,320	10.3-10.8
226-375	8	530	2,320-3,530	9.4-10.3
376-500	8	600	3,530-4,600	9.2-9.4
501-1,000	8	600	4,600-8,600	8.6-9.2
1,001-1,500	7.8	600	8,600-12,300	8.2-8.6
5. Seminar-Conference Rooms				
Up to 10				
11-20	20	--	up to 200	up to 20
21-30	20	--	200-400	18.8-20.0
	18	--	400-540	18.0-19.1
6. Unconventional Rooms[1]	--	--	--	--

1. In those cases where an institution is planning unconventional classrooms to meet the requirements of unusual teaching techniques, it will be necessary to explain the techniques, describe the uses made of the rooms, establish the space requirements for each occupant, etc.

Source: Coordinating Board, Texas College and University System, 1982, p. D1-6.

standards emerge as slightly more restrictive at the undergraduate level and considerably more so at the graduate level. To illustrate this point, Texas' graduate space factor standards in the biological and physical sciences are mostly in the range of 4.65 to 4.95 assignable square feet per weekly student contact hour. California has no graduate teaching laboratory standard, so its upper-division standards of 3.41 for the biological sciences and 3.98 for the physical sciences apply. Effectively, therefore, Texas' standards for these disciplines are about 20 to 40 percent more lenient than California's.

The Texas Coordinating Board also supplied Fall 1978 utilization data for classrooms and laboratories based on the weekly room hours and station occupancy rates of 23 public four-year institutions in Texas. From these, it is possible to derive weekly station occupancy rates that average 22.6 weekly

DISPLAY 25 *Texas Teaching Laboratory Standards for Engineering and the Natural Sciences in Assignable Square Feet per Station and per Student Station Periods of Occupancy (SSPO)[1] Compared to California Standards*

Discipline	Total ASF/Station[2] (All levels unless otherwise specified)	Space Factor (ASF/SSPO[1]) (All levels unless otherwise specified)
Biological Sciences		
Bacteriology	59.4[3]-79.2[4]	3.71[3]-4.95[4]
Biochemistry	62.0[3]-74.4[4]	3.88[3]-4.65[4]
Biological Science, General	43.4	2.71
Botany	43.8[3]-75.0[4]	2.74[3]-4.69[4]
Entomology	43.4[3]-74.4[4]	2.71[3]-4.65[4]
Genetics	45.5[3]-74.4[4]	2.71[3]-4.65[4]
Microbiology	55.8[3]-74.4[4]	3.49[3]-4.65[4]
Physiology	55.8-124.0	3.49-7.75
Zoology		
a. Introductory, Comparative anatomy, Physiology	4.2	2.62
b. Vertebrate, Invertebrate, Cytology, Embryology, Enzymology, Parasitology, Histology, Morphology, Ornithography, Ecology, Limnology, Taxonomy.	54.0	3.38
California Standard (CCHE): Lower-Division	55	2.23
Upper Division	60	2.75
Physical Sciences		
Astrogeophysics	49.6[3]-74.4[4]	3.10[3]-4.65[4]
Astronomy	31.0[3]-74.4[4]	1.94[3]-4.65[4]
Astrosphysics	62.0[3]-74.4[4]	3.88[3]-4.65[4]
Atmospheric Science	49.6[3]-74.4[4]	3.10[3]-4.65[4]
Chemistry	50.0[3]-75.0[4]	3.12[3]-4.69[4]
Engineering Physics	49.6[3]-74.4[4]	3.10[3]-4.65[4]
Geology	49.2[3]-73.8[4]	3.08[3]-4.61[4]
General Physical Science	43.4	2.71
Meteorology	49.6[3]-74.4[4]	3.10[3]-3.65[4]
Physics	50.0-75.0	3.12-4.69
California Standard (CCHE): Lower Division	60	1.81
Upper Division	70	2.63
Engineering Sciences		
Agricultural	53.1-236.0	3.32-9.83
Chemical	35.4-177.0	2.21-11.06
Civil	59.0-177.0	3.69-11.06
Electrical	53.1-147.5	3.32-9.22
Industrial	76.7	4.79
Mechanical	59.0-236.0	3.69-14.75
Mining	147.5	9.22
Petroleum	118.0-177.0	7.38-11.06
California Standard (CCHE): Lower Division	90	4.72
Upper-Division	110	2.50

1. Student station periods of occupancy per week (based on a utilization standard of 20 hours per laboratory per week (8:00 a.m. to 5:00 p.m.) at an 80 percent station occupancy rate) is a measure equivalent to weekly student contact hours.
2. Including service areas.
3. Undergraduate level. (Several area standards are normally specified for various subdisciplines and occasionally for lower/upper division instruction. The number shown is the lowest in the range.)
4. Graduate level.

Source: Coordinating Board, Texas College and University System, 1982 and Coordinating Council for Higher Education, 1966.

room hours of use for classrooms and 16.5 weekly room hours for teaching laboratories. To those figures, percentage occupancy totals of 56.1 and 79.9 for classrooms and laboratories, respectively, can be applied to produce weekly station occupancy rates of 12.7 hours for classrooms and 13.2 hours for laboratories. In the State University, the comparable numbers are 29.7 for classrooms, 22.0 for lower-division laboratories, and 19.3 for upper-division laboratories. It certainly appears from this that Texas' institutions are not using their facilities nearly as efficiently as the State University, but the Texas data nevertheless place that state somewhere near the mean of other states surveyed in this report.

Virginia

Like Ohio, Texas, and a few other states, Virginia appears to be among the national leaders in the field of space planning. In a 1984 report, its State Council of Higher Education observed (p. 2):

> There should be an effort within each individual state to develop a facilities planning system which reflects the higher education goals and objectives and the unique array of institutional characteristics within the state's system of higher education. Inherent in the development of such a planning system is the assumption that there is a rational means for determining the space requirements of the system as a whole and for the individual colleges and universities within that system. It should be recognized, however, that there are good and sufficient reasons why procedures and guidelines developed by an individual state must be unique and tailored to specific needs. *It should also be recognized that the term "guidelines" is chosen intentionally, recognizing that all of the values developed are averages derived from research and experience.* Thus, they must be regarded as points in a range.

The Council went on to add:

> [Operating] procedures must permit the institution which exceeds the limits set by the space planning guides to present its own, more detailed data as the basis for justifying its deviation from the norm. This recognizes that no generalized planning or evaluative process can reflect all the nuances of the institutional situation and that complete dependence on an imperfect system is unwise and unwarranted. Accordingly, these evaluative processes should be used to define areas requiring further discussion rather than to provide a final, unilateral answer. Further, where "excess" facilities in fact exist, the institution must be granted sufficient time and resources to "correct" such situations.

With those philosophical constraints in mind, Virginia developed its space standards on the same basis as California and many other states, by using a formula based on both assignable square feet per station and a utilization standard. For classrooms, it gives institutions the option of following either daytime, or day and evening standards. These standards are shown in Displays 26 and 27 on page 38. Similar data for class laboratories are shown in Displays 28 and 29 on page 39.

For faculty research laboratories in the sciences, Virginia provides a standard of 1,100 assignable square feet per full-time-equivalent faculty member, assuming that this area will also accommodate four graduate students. It provides an additional 225 assignable square feet for each additional graduate student. The disciplines to which this standard applies include agriculture and natural resources, engineering, computer science, biological sciences, applied mathematics and statistics, and the physical sciences.

Florida

The Florida State Department of Education's space and utilization standards for classrooms are shown in Display 30 on page 40; those for teaching laboratories appear in Display 31 on that same page. From these displays it can be seen that California's standards are more restrictive than Florida's in every category -- hours of weekly room use, percent station occupancy, assignable square feet per station, and assignable square feet per weekly student contact hour. In June 1985, Florida endeavored to increase its utilization standard, but only for community colleges. Its new standard calls for weekly room use at 90 percent of the hours available from 8 a.m. to 10 p.m., five days a week, or 58.5 hours a week. It reduces its station occupancy percentage, however, from 67 percent to 60 percent except for institutions

DISPLAY 26 *Virginia 8 a.m. to 5 p.m. Classroom Space and Utilization Standards Based on Total Full-Time Equivalent Day Enrollment, Compared to California 8 a.m. to 10 p.m. Standards*

Type of Institution	ASF/Station	Utilization Standards: Weekly Room Hours (8 a.m. - 5 p.m.)	Utilization Standards: Station Occupancy Percentage	Space Factor (ASF/WSCH)
Comprehensive Colleges, Liberal Arts Colleges and Specialized Institutions				
1,000 - 2,499 students	16	30	62.5%	.85
2,500 or more students	15	31	60.0%	.81
Doctoral Granting Institutions	15	30	60.0%	.83
California Standards, 8 a.m. to 10 p.m.	15	53	66.6%	.43

Source: State Council of Higher Education for Virginia, 1984, p. 11.

DISPLAY 27 *Virginia 8 a.m. to 10 p.m. Classroom Space and Utilization Standards Based on Total Full-Time-Equivalent Day and Evening Enrollment, Compared to California 8 a.m. to 10 p.m. Standards.*

Type of Institution	ASF/Station	Utilization Standards: Weekly Room Hours (8 a.m. - 10 p.m.)	Utilization Standards: Station Occupancy Percentage	Space Factor (ASF/WSCH)
Comprehensive Colleges, Liberal Arts Colleges and Specialized Institutions				
1,000 - 2,499 students	16	40	62.5%	.64
2,500 or more students	15	41	60.0%	.61
Doctoral Granting Institutions	15	40	60.0%	.63
California Standards, 8 a.m. to 10 p.m.	15	53	66.6%	.43

Source: State Council of Higher Education for Virginia, 1984, p. 12.

with less than 2,500 full-time-equivalent students. For them, its occupancy rate is only 55 percent. It also reduced its assignable-square-feet-per-station allowance from 20 to 13. The effect is to reduce its assignable square feet per weekly student contact hour to the lowest found so far in the country -- .3704 to .4040, depending on the size of the institution. This space standard is about 5 to 10 percent stricter than California's.

Florida's space standards for research laboratories are shown in Display 32 on page 41 for selected disciplines.

In 1985, Florida's State Department of Education issued a directive that offered specific standards rather than the ranges shown in Display 32. With the exception of agriculture, all of these came in on the high side, allowing 450 assignable square feet

DISPLAY 28 *Virginia 8 a.m. to 5 p.m. Teaching Laboratory Space and Utilization Standards Based on Total Full-Time-Equivalent Day Enrollment, Compared to California 8 a.m. to 5 p.m. Standards*

Type of Institution	Average ASF/Station	Utilization Standards: Weekly Room Hours (8 a.m. - 5 p.m.)	Utilization Standards: Station Occupancy Percentage	Space Factor (ASF/WSCH)
Comprehensive Colleges, Liberal Arts Colleges and Specialized Institutions				
Heavy Laboratories				
1,000 - 2,499 students	100	18	72.5	7.66
2,500 or more students	100	20	70.0	7.14
Other Class Laboratories				
1,000 - 2,499 students	50	18	72.5	3.83
2,500 or more students	50	20	70.0	3.57
Doctoral Granting Institutions				
Heavy Laboratories	100	18	70.0	7.97
Other Class Laboratories	50	18	70.0	3.97
California Standards, 8 a.m. to 10 p.m.				
Lower Division	30-90	27.5	85.0	.18 - 4.72
Upper Division	30-110	22.0	80.0	.09 - 4.14

Source: State Council of Higher Education for Virginia, 1984, p. 19.

DISPLAY 29 *Virginia 8 a.m. to 10 p.m. Teaching Laboratory Space and Utilization Standards Based on Total Full-Time-Equivalent Day and Evening Enrollment, Compared to California 8 a.m. to 10 p.m. Standards*

Type of Institution	Average ASF/Station	Utilization Standards: Weekly Room Hours (8 a.m. - 10 p.m.)	Utilization Standards: Station Occupancy Percentage	Space Factor (ASF/WSCH)
Comprehensive Colleges, Liberal Arts Colleges and Specialized Institutions				
Heavy Laboratories				
1,000-2,499 students	100	23	72.5	6.00
1,500 or more students	100	25	70.0	5.71
Other Class Laboratories				
1,000-2,499 students	50	23	72.5	3.00
2,500 or more students	50	25	70.0	2.86
Doctoral Granting Institutions				
Heavy Laboratories	100	23	70.0	6.21
Other Class Laboratories	50	23	70.0	3.11
California Standards, 8 a.m. to 10 p.m.				
Lower Division	30-90	27.5	85.0	.18 - 4.72
Upper Division	30-110	22.0	80.0	.09 - 4.14

Source: State Council of Higher Education for Virginia, 1984, p. 20.

DISPLAY 30 Recommended Values for Space Utilization Standards and Standardized Space Factors in Florida Universities, Compared to California

Type of Space	Hours of Weekly Room Use		Percent Station Occupancy		ASF[1] per Station		Space Factor ASF/WSCH[2]	
	Florida	Calif.	Florida	Calif.	Florida	Calif.	Florida	Calif.
Classrooms	36	53	67%	66%	20	15	.83	.43
Classrooms at Evening Centers Only	17	(3)	67%	66%	20	(3)	1.76	(3)
Teaching Laboratories								
Lower Division	24	27.5	80%	85%	(4)	(4)	(4)	(4)
Upper Division and Graduate	20	22.0	70%	80%	(4)	(4)	(4)	(4)
Combination Lower and Upper Division	22	None	75%	None	(4)	None	(4)	None

1. ASF: Assignable square feet.
2. WSCH: Weekly student contact hours.
3. Included within standard for "classrooms."
4. Variable depending on discipline.

Source: Florida State Department of Education, 1983(a), p. 23, and Coordinating Council for Higher Education (California), 1966, as modified by the California Legislature in 1970 and 1973.

DISPLAY 31 Florida Standard Station Area Values for Teaching Laboratories in Engineering and the Natural Sciences, Compared to California Standards

Discipline and Level		Assignable Square Feet per Station		Space Factor (ASF/WSCH)	
		Florida	California[2]	Florida	California[2]
Biological Science:	Lower Division	55	55	2.86	2.23
	Upper Division	80[1]	60	5.00[1]	2.75
Engineering:	Lower Division	55	90	2.86	4.72
	Upper Division	125[1]	110	7.81[1]	2.50
Physical Science:	Lower Division	55	60	2.86	1.81
	Upper Division	75[1]	70	4.69[1]	2.63

1. For Florida, this standard applies to both upper division and graduate.
2. 1966 Coordinating Council standards with utilization modified by legislative standards (undergraduate only).

Source: Florida State Department of Education, 1983(a), p. 23, and Coordinating Council for Higher Education (California), 1966, as modified by the California Legislature in 1970 and 1973.

per full-time-equivalent faculty member in all of the disciplines from engineering through geology, and 375 assignable square feet for psychology. Anthropology and geography were not allocated specific standards, so it must be assumed that they are included within other discipline categories just as they are at present in California.

New York

Among the states surveyed for this report, the most elaborate space and utilization standards are those developed by the State University of New York (SUNY). For its four university centers, SUNY has produced specific standards (or "guidelines," as it

DISPLAY 32 Florida Space Standards for Research Laboratories, Compared to California Standards

Discipline	Net Square Feet per Occupant for Research Facilities			1955 Restudy Standards for the University of California
	Minimum	Normal	Maximum	
Agriculture	400	450	500	300
Engineering	350	400	450	300
Biology	250	350	450	250
Zoology	250	350	450	250
Chemistry	250	350	450	250
Physics	250	350	450	250
Geology	250	350	450	250
Psychology	175	275	375	N/A
Geography	150	200	250	N/A
Anthropology	125	150	175	N/A

Source: Florida State Department of Education, 1983(b), p. 81, and McConnell, Holy, and Semans, 1955, p. 348, Table 34.

prefers to call them) for no less than 186 disciplines and 207 disciplines for its 13 colleges of arts and sciences. Originally formulated in 1970, these standards are all based on assignable square feet per full-time-equivalent student and have been updated about every five years. The most recent version dates to 1980, but New York is currently in the process of producing another update which should be available by the time the second phase of California's study is under way.

Making comparisons between New York and California is exceedingly difficult due to the marked differences in the way the two states apply their standards. The only viable comparison is to the standards for assignable square feet per full-time-equivalent student developed for the 1955 Restudy, for those few disciplines where matches are possible. Even at that, however, the comparison is less than exact, since California and New York do not produce full-time equivalents in precisely the same way. For the data to be strictly comparable, it would be necessary to have identical student/faculty ratios and number of credit hours per full-time equivalent in all disciplines being compared, and that cannot be assured even though, in all probability, there is little variation between the student-faculty ratios and credit hours of the two states.

New York also varies from California in that SUNY uses its guidelines as a day-to-day planning tool with wide internal institutional uses rather than as State-imposed standards within which its campuses are allowed a degree of flexibility. This difference in approach is crucial, because it is unlikely that standards as detailed as New York's would be practical if promulgated by the Commission or the Legislature in California.

In 1970, New York used a weekly room use factor of only 24 hours for classrooms and allowed 16 assignable square feet per station. That produced a space factor of six to ten assignable square feet per full-time-equivalent student, depending on the conversions between contact hours and full-time-equivalent students. In the intervening ten years, these standards have tightened somewhat to the point where they now appear to be in the range of four to eight assignable square feet per full-time-equivalent student. In all probability, the 1970 standards would have produced a space factor of about 1.00 assignable square feet per weekly student contact hour (compared to .425 in California) -- a standard not at all uncommon for much of the country then and even now. Given the tightening since, it seems likely that New York's classroom standard, and probably its teaching laboratory standards as well, have come closer to California but are still less rigorous.

New York's allowances for research laboratories cannot be determined without additional information from SUNY, but it is clear that New York affords official recognition to postdoctoral students -- the only State in this survey that does so -- and, although it is too soon to make a definitive statement on the question of research space, it appears from the data that New York's allowances for research laboratories are somewhat more generous than California's. California allocates research space on the basis of assignable square feet per full-time-equivalent faculty member and headcount graduate student, while New York's formulas generate all space on the basis of full-time-equivalent student, thus making comparisons difficult. Nonetheless, as of 1970, SUNY allowed 360 assignable square feet per station in physics, chemistry, and several other of the physical sciences. Using its conversion factors for contact hours and full-time equivalents, this guideline translated into a space factor of 180 assignable square feet per full-time-equivalent student for faculty research laboratories. As of 1980, this factor had been reduced to 153, but an additional factor had been added for postdoctoral fellows who were unrecognized in 1970. If the relationship between assignable square feet per station and assignable square feet per full-time-equivalent student has remained the same, SUNY's current standard should be 306 assignable square feet per station for faculty alone and a great deal more once postdoctorals are included. In California, the standard remains at 250 for faculty and 145 for graduate students -- the same level it has maintained since 1955. Further exploration of SUNY's standards will doubtless reveal a clearer picture of its real space allocations, but the probability seems high that it allocates more research space for faculty, graduate students, and other researchers than does California.

Summary

This chapter has reviewed the space and utilization standards from 13 states that submitted documents to the California Postsecondary Education Commission and from 10 others surveyed by the Nebraska Coordinating Commission for Postsecondary Education. The data from these states can be divided into three categories: (1) utilization standards for classrooms and teaching laboratories; (2) space standards for the same facilities; and (3) space standards for research laboratories. From the available data, it is clear that California maintains the highest utilization standards and among the tightest space standards of the 23 states surveyed. Only Oklahoma reportedly maintains a higher utilization standard, but the absence of utilization data from that state prevents a conclusion about the degree to which it is meeting those standards.

For classrooms, space standards in the other states tend to range between 15 to 20 assignable square feet per station, while California uses a factor of 15. A few states with refined systems for evaluating classroom space by size allow fewer square feet for large lecture halls and more for seminar rooms. Utilization standards fall into a range of between 27 and 33 hours per week with most states opting for 30 hours a week at 60 percent station occupancy, while California uses 53 hours with 66.6 percent station occupancy.

For teaching laboratories, many states are not at the point where they have derived specific allocations by discipline. Some use only a general laboratory standard, others make a distinction between "heavy" laboratories and others, still others have developed four or five categories into one of which all disciplines must fit. In general, those that have developed any specificity with regard to teaching laboratories tend to allow between 50 and 80 assignable square feet per student station for the natural sciences. For engineering, the range is much wider in those states which have disaggregated engineering into numerous subdisciplines. For those which have one

or only a few space standards, the range is between 90 and 130 assignable square feet per station. All of these standards are not grossly dissimilar from California's, but they become so when utilization standards are applied to produce the space factor of assignable square feet per weekly student contact hour. Most of the states surveyed employ a utilization standard of about 20 hours per week at 80 percent station occupancy, California uses 23.4 at 85 percent for lower-division and 17.6 at 80 percent for upper-division instruction. Thus California generally grants a few less square feet per student than most other states.

The largest remaining question concerns graduate student and faculty research laboratories. Data were available from only four states -- Florida, New York, Ohio, and Virginia -- but all four appear to allow more generous laboratory space allowances than does California under the 1955 Restudy standards.

4 *University of California and California State University Perspectives on Space and Utilization*

University of California

Display 33 on page 46 shows the amounts approved in the 1985-86 Budget Act for University of California capital outlay as well as the Regents' request for 1986-87. Both indicate the major priority accorded by the University to engineering and the natural sciences -- between 66 and 75 percent of the total dollar amounts.

In its requests for both years, the University deviated from the established space standards in a number of important ways. Display 34 presents, by campus, the total percentage variation from the standards, for the three disciplines of greatest concern, that will occur when projects currently funded or proposed for funding in 1986-87 are completed. These projects will be completed over several years culminating in the early 1990s. It can be seen that in a number of cases the total square footages requested for the natural sciences will exceed the standards by considerable percentages, while in engineering , the space the University deems necessary is below the standards. In each case, 100 percent indicates that the University's plans meet the standards exactly; a percentage above 100 means that plans involve greater square footage allotments than those provided by the standards.

Display 34 on page 47 shows that in engineering, the University is not using as much space as the standards permit, but that in the biological and physical sciences, its plans go beyond them. It also reflects the University's position that the standards are adequate for engineering but inadequate in the natural sciences. However, the totals shown conceal the fact that capital planning involves the application of standards in many different space categories, (including classrooms, teaching laboratories, graduate research space, and faculty offices) and does not include a qualitative evaluation of the suitability or obsolescence of existing space. In the case at hand, the University's major difficulty concerns research laboratories, where it argues that technology, advances in knowledge, changing research techniques, and an increase in the size of research teams have rendered the standards obsolete. For teaching laboratories, the University's position is that existing space factors are more adequate than those for research laboratories, but that the individual components which are part of the overall standard should be updated. Specifically, the weekly student contact hours for laboratory courses should be updated to reflect an increasing emphasis on laboratory-based courses over the past 20 years; the square footage allowance per station needs review because of space required to accommodate state-of-the-art equipment; and the need for special support areas should be incorporated into the space guidelines. The utilization rate component of the guidelines does not appear to provide a problem for the University at this time.

The standards for classroom space are different for each academic discipline, although they conform to the overall standard of 15 assignable square feet per station. They are applied based on projected enrollments in each discipline, then totaled for each campus. In conjunction with the Commission's review of instructional laboratory space, the University believes that the square footage allotment per weekly student contact hour should be updated to reflect changes in the curriculum. In addition, the University believes that the space per station standard for classrooms should be modified to reflect a range of square feet per station based on the size of classrooms proposed and support space required. An example cited by the University is the larger amount of space per station needed in small seminar rooms compared to large lecture halls; science demonstration lecture halls usually require even greater amounts of space. Most significantly, the University maintains that the utilization standard for classrooms, based on a scheduled use of 53 hours per week, is unreasonable and cannot be achieved, given the mix of classroom sizes available, the relatively low percentage of part-time students enrolled in the University, and the problems associated with scheduling classes at certain times of the day.

DISPLAY 33 *State Funded University of California Capital Outlay Projects for Science and Engineering (Excluding Health Sciences) Contained in the 1985-86 Governor's Budget and the 1986-87 Regents' Request*

Campus or Program and Project	1985-86 Governor's Budget ($000s)	1986-87 Regents' Request ($000s)
Berkeley		
Genetics and Plant Biology Building	$1,601	$17,734
Animal Facility Corrections	607	0
Life Sciences Renovation	588	888
Life Sciences Addition	0	3,957
Etcheverry Hall Alterations	130	1,304
Northwest Animal Facility	0	450
Davis		
Food and Agricultural Sciences Building	$4,682	$0
Asmundson Hall and Mann Laboratory Remodel	300	2,417
Environmental Toxicology Building	0	823
Irvine		
Engineering Laboratory Facility	$5,050	$2,259
Physical Sciences, Unit 2	667	27,559
Biological Sciences Unit 2	0	1,231
Physical Sciences Unit 1 Renovation	0	357
Los Angeles		
School of Engineering and Applied Sciences Addition	$45,388	$1,590
School of Engineering and Applied Sciences Retrofit	302	392
Chemistry and Biological Sciences Addition	0	1,350
Riverside		
Replacement of Greenhouses	$114	$2,056
San Diego		
Engineering Building Unit 1	$33,070	$8,926
Scripps Institution Seawater Supply System	3,065	0
Instruction and Research Facility[1]	400 [1]	17,600 [1]
	(160)	(7,040)
Santa Barbara		
Engineering Unit 2	$4,387	$0
Biotechnology Seawater Laboratory	428	6,375
Santa Cruz		
Computer Engineering Alterations	$2,263	$0
Natural Sciences Unit III	550	20,450
Science Library Addition	0	600
Natural Sciences Released Space	0	185
Agriculture and Natural Resources Program		
Kearney Agricultural Center Development	$383	$4,677
Imperial Valley Agricultural Center Addition	0	732
Totals		
Engineering/Science Related Projects	$103,375	$113,352
Other Projects	33,164	58,240
Governor's Budget/Regents' Request Total	$136,899	$171,592
Percent Science and Engineering	75.5%	66.1%

1. Approximately 40 percent of this building is for the sciences, the remainder for liberal arts and humanities. Only the 40 percent (shown in parenthesis) is reflected in the totals.

Source: Letter to William L. Storey from Trudis L. Heinecke, January 16, 1986.

Display 34 Percentage Variations from Existing Space and Utilization Standards in the University of California's Capital Outlay Plans for Its Eight General Campuses, 1989-90

Campus	Biological Sciences	Physical Sciences	Engineering
Berkeley	150%	121%	77%
Davis	110	99	59
Irvine	126	140	67
Los Angeles	130	129	95
Riverside	142	124	N/A
San Diego	87	100	72
Santa Barbara[1]	146	101	77
Santa Cruz	114	88	64
Mean[2]	125.6%	112.8%	73.0%

1. Percentages apply to total space in each discipline, not just specific capital outlay requests.
2. Weighted by total existing square feet on each campus, 1984-85.

Source: University of California Project Planning Guidelines.

To present its case for adjustments in the standards for natural science research laboratories, the University asked several of its faculty members to develop papers answering a number of specific questions:

- Over the past 25 or 30 years since the *Restudy* standards were developed, how has the nature of instruction and research changed?
- At what level of instruction -- lower division, upper division, graduate, or independent research activity -- have the changes been most apparent?
- How have these changes affected space requirements?

As of this writing, three papers have been transmitted, one each for the fields of microbiology, organic chemistry and electrical engineering. The organic chemistry and engineering papers were submitted in draft form with the request that they not be published until further review.

Changes in microbiology

The two papers received to date note that the scientific fields have changed dramatically in the past several decades, and the microbiology paper offers the observation that it has expanded so much that it has probably existed as a separate discipline -- rather than a branch of bacteriology -- only since the early 1970s. Advances in scientific knowledge, and the equipment used to obtain that knowledge, have had the effect of creating required courses that did not exist a quarter-century ago. Some of these courses are substitutes for earlier requirements, but most are additions, and the result has been that students today are required to take a greater number of courses than they once did, most of them involving substantial laboratory exposure.

Equipment requirements have also changed, as both the microbiology and organic chemistry papers indicate. The former contains the following comment (p. 3):

> In 1960, a typical class lab was equipped with Bunsen burners, optical microscopes, water baths, incubators, and colorimeters. Today, in addition to that equipment, electrophoresis units, ultraviolet spectrophotometers, high-speed centrifuges, enzyme-linked assay systems, precision mechanical micropipettes, and instruments for cell culture experiments are required. Since much of this equipment is shared by many students or the entire lab, the amount of space required for each student work station has not changed appreciably. However, additional instrumentation requires a variety of specialized support rooms, often in centralized support areas, to service a group of teaching laboratories.

Another comment concerns postdoctoral fellows, and it notes that in 1960, postdoctoral training was almost nonexistent (p. 4):

> In 1985, post-doctoral training is a virtual prerequisite for an academic or industrial career. This is a result of several historical factors: (1) the availability of extramural funding for research training after the Soviets launched Sputnik in 1957; (2) the increased complexity and sophistication of research activities, which requires more people in the research lab to

perform typical research functions, and personnel who have been more intensively trained in specific research methodologies; (3) a shrinking job market in the 1970s which greatly increased the competitive nature of job placement in both industry and academia; and (4) a renewed requirement for U.S. competitive high technology in the 1980s and 1990s, demanding an expansion of advanced graduate training.

The University maintains that the effect of these factors -- the broadening of the curriculum, the increased amount and sophistication of equipment, the increase in required research laboratory exposure for upper division and graduate students, and the expanded use of postdoctoral fellows -- has been to expand substantially the space needs in modern academic laboratories. Beyond even these considerations, however, the University adds (p. 7):

> An additional impact has been caused by the changes in health and safety laws and code requirements. The tremendous growth in materials, substances, and organisms employed in modern research has been matched by a greatly enhanced awareness of the hazardous nature of daily or even occasional contact.

The University claims that, taken together, these changes have created an array of space problems that could not have been imagined in the 1950s when the Restudy standards were developed. They include wider bench and desktop areas, the installation of fume hoods and biocontainment rooms, added space for electron microscopes and other shared equipment, and even conference rooms where research teams can discuss their work.

Changes in organic chemistry

All the changes appear to be equally true in organic chemistry, as the University's paper on the subject suggests. Although the types of equipment vary and include such items as nuclear magnetic resonance spectrometers and X-ray crystallographers, they are no less sophisticated than the equipment used for microbiology, and could well require at least as much space. In the paper discussing this field, computers are emphasized to a greater degree than in microbiology, while the importance of certain other kinds of equipment is not stressed, but the thrust of the paper is very similar to that in microbiology. Common threads include the increased emphasis on laboratory work, the extensive use of postdoctoral fellows, the greater space needs occasioned by the use of modern equipment, the evolution of safety requirements, and the wide and increasing use of research teams rather than individual researchers.

Changes in electrical engineering

The paper discussing electrical engineering, however, has a somewhat different tone. While noting the many technological changes occasioned by the development of microprocessors, the paper indicates that postdoctorals are not used nearly as extensively as in the sciences. Some space needs have clearly increased, but some of them have been offset by advances in miniaturization, and this leads to the following conclusion:

> A preliminary assessment indicates that quantitatively, the Restudy standards probably give a reasonable estimate of the overall space needs for electrical engineering. However, the quality and sophistication of the required space substantially exceeds what was envisaged twenty-five years ago.

For all of these reasons, the University has adopted the position that the space standards for scientific research laboratories in the sciences are in need of upward revision to account for changes in the academic environment that have occurred since 1955. In engineering, however, the need for revision in the existing allowances is considerably less evident.

The California State University

Display 35 on page 50 shows the amounts contained in the 1985-86 Budget Act for capital outlay in the California State University as well as the Trustees' request for 1986-87. These figures also indicate a strong emphasis on engineering and the sciences, although to a lesser extent than at the University of California.

Unlike the University, the State University did not deviate from the current space and utilization standards when it compiled its capital outlay requests for 1985-86 and 1986-87, but its leadership still sees the need for at least ten changes (California State University, 1985):

1. Faculty office space: Given current requirements for student counseling, course preparation, and other activities, as well as the needs for computing and word processing space, the existing standard of 110

square feet per faculty office is inadequate. The allotment should be increased to 125 square feet to apply through the 1987-88 fiscal year, with an additional allowance for support space. In Phase Two of the Commission's study, a nationwide survey should be conducted to determine an appropriate permanent standard.

2. *General lecture:* The State University believes the 53-hour utilization standard is unreasonable and should be reduced to 45 hours per week. This will bring it closer to national norms.

3. *Auditorium and large lecture spaces:* During Phase II of the Commission's study, utilization standards should be modified "to recognize that different size lecture spaces should have different utilization standards" due to the additional time required for setup and takedown.

4. *Instructional laboratories (teaching laboratories):* The existing utilization standards should be reduced to the levels approved by the Coordinating Council for Higher Education in 1966. In addition, existing space and utilization standards cover too few disciplines. The Commission should survey other institutions to determine if new standards can be established for additional categories of space.

5. *Self-instructional laboratories:* Standards do not currently exist for this type of space, and there are special needs in such areas as cartography, art studios, and journalism. The Commission should survey other institutions to determine appropriate standards.

6. *Instructionally related research spaces (research laboratories):* The State University "has the obligation to provide space for faculty and graduate students to conduct instructionally related research," yet the current standards do not provide for these spaces officially. It is noted that an informal standard exists whereby the State University can receive 75 percent of the allowance accorded to the University of California provided the need for that space can be related to the instructional program. It is suggested that this standard be made official.

7. *Visual and performing arts spaces:* There is no authorized space standard for such areas as art galleries, dance practice areas, music practice studios, or specialized recital halls other than the assembly and exhibition areas associated with the visual and performing arts. The Commission should survey other states "with the objective of establishing appropriate and reasonable standards."

8. *Self instructional computing laboratories:* These recommendations are contained in the Commission's recent report on the subject (85-39; 1985).

9. *Lockers and locker room storage areas:* The State University maintains that no space standards exist for locker areas in spite of the need in such disciplines as physical education and the arts. It is recommended that such standards be established after the Commission conducts a survey of other states.

10. *Student activity areas:* A new standard is proposed to provide for space for professional organizations, chapter meetings, and student/faculty discussion areas in order to "encourage the development of academically related professional associations which . . . enhance the student's educational enrichment. It must be emphasized that CSU is not advocating the State funding of activities which are normally supported via student fees, such as student unions." As with the other recommendations, a national survey is urged to determine if such spaces are provided in comparable institutions.

In a final comment, the State University offers a number of suggestions as to how the Commission's major study could be conducted. It involves an examination of the work done by the Commission and the segments in 1975, the retention of a consultant, a survey of other states, and ample time for segmental consultation. It also indicates its concurrence with the University of California's recommendation that guidelines for research laboratory space in the sciences should be increased.

The State University's recommendations closely parallel the University of California's in a number of areas, including those for the liberalization of the existing standards for classrooms, and teaching and research laboratories. The State University also offers a number of other recommendations. For example, it makes a point in several of its comments about auxiliary spaces for lockers, practice areas in the arts, and student activities. The assumption of the existing space standards has always been that such areas are included within the overall standards. The fact that the State University argues for special consideration regarding such spaces could indicate that the existing standards are too re-

DISPLAY 35 *State Funded California State University Capital Outlay Projects for Science and Engineering Contained in the 1985-86 Governor's Budget and the 1986-87 Trustees' Request*

Campus/Project	1985-86 Budget Act (000s)	1986-87 Trustees' Request (000s)
Bakersfield	$0	$0
Chico	0	0
Dominguez Hills	0	0
Fresno	0	0
Fullerton		
Engineering Building Addition	321	7,203
Hayward	0	0
Humboldt		
Remodel Science Building	613	135
Long Beach		
Engineering/Computer Science/Math Laboratories	11,782	0
Renovate Chemistry Laboratories	0	2,454
Los Angeles	0	0
Northridge		
Science Addition and Remodeling	827	12,850
Pomona	0	0
Sacramento		
Engineering/Computer Science Addition	460	10,895
San Bernardino	0	0
San Diego		
Physical Science Building Rehabilitation	2,141	3,511
Life Science Building Rehabilitation	248	174
San Francisco		
Convert Science Building	383	0
Science Chemical Fume Hoods	233	0
Faculty Office Addition to Science Building	86	1,142
San Jose		
Engineering Building	525	26,489
Renovate Old Science Building	0	390
San Luis Obispo		
Engineering South Building	1,779	0
Agricultural Science Building	6,128	0
Remodel Engineering East Building	0	160
Dairy Science I, Instructional Center	0	270
Sonoma	0	0
Stanislaus	0	0
Totals		
Engineering/Science Related Projects	$25,526	$65,673
Other Projects	35,305	51,291
Governor's Budget/Trustees' Request Total	$60,831	$116,964
Percent Science and Engineering	41.9%	56.1%

Source: The California State University and 1985-86 Governor's Budget.

strictive in a few areas or that special needs have arisen since the 1950s and 1960s which require the establishment of specific allotments. This question, as with many others, will be addressed by the Commission later in 1986.

In considering the State University's comments on the existing standards, it should be remembered that they are preliminary and were developed on short notice. In the coming months, it is probable that many of its comments will be expanded or revised as research into the subject proceeds. They constitute a basis for future discussions, but they should not be considered definitive.

California Community Colleges

The Community Colleges did not participate as actively in this first phase of the space and utilization study, principally because the Supplemental Language was directed to the four-year segments, but at both meetings of the technical advisory committee, the Chancellor's Office offered its view that the classroom and teaching laboratory standards were overly restrictive. In the second phase of this study, that segment's concerns will be fully considered.

Summary

This chapter has presented two displays showing the capital outlay allocations contained in the 1985-86 Budget Act, the requests by the Regents and the Trustees for 1986-87, and the amounts applicable to engineering and natural science disciplines. These allocations and requests represent about two-thirds of the capital outlay allocations and requests at the University of California and about half of the building program in the California State University. A concentration of this magnitude directed to engineering and science construction and renovation gives a clear indication of segmental priorities at the present time.

5 *Changes in College and University Research Funding and Staffing*

AS Chapter Four noted, the University of California claims that the space requirements for research activity in certain disciplines have increased markedly since the early 1950s when the Liaison Committee developed the research laboratory standards that were published as part of the 1955 Restudy. The reasons given include the increasing amount and sophistication of scientific equipment needed for modern explorations and the fact that more researchers and technicians are required to solve contemporary research problems.

To determine the validity of this claim, the Commission reviewed data from the National Science Foundation to determine changes in research funding that have occurred in the post-World War II era. Displays 36 and 37 on pages 54 and 55 show the growth since the early 1950s, and Display 38 on page 56 shows the growth in selected disciplines since 1972.

Growth of research funds

Display 36 -- reprinted from *Academic Science/ Engineering: 1972-83*, published by the National Science Foundation in 1984 -- shows total research appropriations to universities and colleges growing from $255 million in 1950 to over $7 billion in 1982. These funds -- virtually all of which were granted to faculty and others at research universities such as the University of California -- grew at an annual rate almost three times that of inflation, while basic research grew at an even faster rate; 13.9 percent each year, compared to the overall annual growth of 12.2 percent.

The most explosive era of growth in research funding occurred between the early 1950s and the late 1960s, as indicated in Display 37. For the 17 years between 1953 and 1970, in constant dollars, the annual growth rate was 11.0 percent, with total research and development funds growing by almost a factor of five. For the 12 years following 1970, total growth was only 37.0 percent, an annual increase of 2.7 percent above inflation.

Although record keeping was not as complete in the 1950s and 1960s as it is today, some recent data compilations indicate that not only has the total amount of research money grown dramatically, the amount per researcher has grown almost as rapidly. Display 38 provides an indication of this for the years between 1972 and 1982 in four specialties of particular concern to this report. It reveals that between 1972 and 1982, the amount of research funding granted per scientist grew at a rate faster than the rate of inflation, particularly in chemistry and engineering.

This pattern of increases in research funding nationally is similar to the University of California's, except that the University appears to have attracted an increasing percentage of total research funds. Display 39 on page 57 shows University of California expenditures from extramural or non-State sources in both current and constant dollars, and it indicates that the increases since the 1950s have been dramatic, particularly between 1950-51 and 1965-66 when funding, in constant dollars, increased 24.9 percent per year overall and 20.5 percent per faculty member. Since 1965-66, the annual increases have been only 3.1 and 0.5 percent, respectively, after adjusting for inflation. All of these percentages exceed by wide margins the national averages for growth in research funding.

At least in part, the tremendous increases in funds devoted to research are responsible for the changes in the way research is conducted. Funding increases, especially from the federal government, have permitted the hiring of large numbers of researchers and the development of hundreds of items of sophisticated and expensive equipment, so much so that the evolution of research teams and the expansion of laboratory space requirements may have been almost inevitable.

Growth of postdoctoral research

Of particular importance in the development of research teams are postdoctoral fellows whose exis-

DISPLAY 36 Research and Development Expenditures at Universities and Colleges by Year and Character of Work, Fiscal Years 1953-82 (Current Dollars)

Fiscal Year	Total Expenditures (Millions)	Basic Research		Applied Research and Development	
		Amount (Millions)	Percent of Total	Amount (Millions)	Percent of Total
1953	$255	$110	43.1%	$145	56.9%
1954	290	136	46.9	154	53.1
1955	312	159	51.0	153	49.0
1956	372	200	53.8	172	46.2
1957	410	240	58.5	170	41.5
1958	456	281	61.6	175	38.4
1959	526	343	65.2	183	34.8
1960	646	433	67.0	213	33.0
1961	763	536	70.2	227	29.8
1962	904	659	72.9	245	27.1
1963	1,081	814	75.3	267	24.7
1964	1,275	1,003	78.7	272	21.3
1965	1,474	1,138	77.2	336	22.8
1966	1,715	1,303	76.0	412	24.0
1967	1,921	1,457	75.8	464	24.2
1968	2,149	1,650	76.8	499	23.2
1969	2,225	1,711	76.9	514	23.1
1970	2,335	1,796	76.9	539	23.1
1971	2,500	1,914	76.6	586	23.4
1972	2,630	2,022	76.9	608	23.1
1973	2,884	2,053	71.2	831	28.8
1974	3,023	2,154	71.2	869	28.8
1975	3,409	2,410	70.7	999	29.3
1976	3,729	2,549	68.4	1,180	31.6
1977	4,067	2,800	68.8	1,267	31.2
1978[1]	4,625	---	---	---	---
1979	5,361	3,612	67.4	1,749	32.6
1980	6,060	4,026	66.4	2,034	33.6
1981	6,818	4,576	67.1	2,242	32.9
1982	7,261	4,851	66.8	2,410	33.2
Annual Percentage Increase	12.2%	13.9%	---	10.2%	---
Annual Increase in GNP Deflator	4.4%	4.4%	---	4.4%	---

1. Data were not collected in 1978.

Source: National Science Foundation. 1984.

DISPLAY 37 R&D Expenditures at Universities and Colleges by Year and Character of Work, Fiscal Years 1953-82 (Constant Dollars)

Fiscal Year	Total Expenditures (Millions)	Percentage Increase from Previous Interval	Percentage Increase Since 1953
1953	$255	---	---
1955	301	18.0%	18.0%
1960	554	84.1	117.3
1965	1,168	110.8	358.0
1970	1,504	28.8	489.8
1975	1,579	5.0	519.2
1980	2,000	26.7	684.3
1981	2,052	2.6	704.7
1982	2,061	0.4	708.2
Total Percentage Increases:			
1953 to 1970	490.0%	---	---
1970 to 1982	37.0%	---	---
1953 to 1982	708.2%	---	---
Annual Percentage Increases:			
1953 to 1970	11.0%	---	---
1970 to 1982	2.7%	---	---
1953 to 1982	7.5%	---	---

Source: Display 36.

tence is not recognized in any California space standards but who nevertheless occupy scientific laboratory space and perform a large amount of the work. According to a 1983 survey (1985a, National Science Foundation, p. 57), 617 American universities reported employing 20,829 postdoctorates that year, virtually all of them (99.8 percent) at doctorate-granting institutions. NSF's estimate for the total number was about 23,000. In addition, there were another 5,000 "non-faculty research staff" who also held doctoral degrees but were not formally placed in the postdoctoral fellow category. Research technicians were not listed.

Among the postdoctorates, 70.3 percent were employed in five fields: -- biological sciences (38.8 percent); physical sciences (20.2 percent); engineering (6.8 percent); environmental sciences (2.8 percent); and mathematics/computer sciences (1.7 percent). The only other field employing large numbers of postdoctoral researchers was the health sciences (23.3 percent).

NSF also ranked universities according to their use of postdoctorates in 1983 (p. 244). Display 40 shows the top ten nationally -- including four University of California campuses in second, fourth, seventh, and eighth place -- as well as the rankings for the other five University of California campuses. It indicates that the University of California received 8.7 percent of all the research and development money expended nationally from all sources and for all purposes in 1983 and employed 12.8 percent of all postdoctoral fellows. Five University campuses ranked in the top 20 nationally in research funds received, and eight of the nine in the top 100. Only Santa Cruz fell outside that category, ranking 137th of the 617 reporting institutions.

In spite of their integral role in the research function at major universities, postdoctorals are not a well recognized group. In his Godkin Lectures at Harvard in 1963, Clark Kerr referred to them as "the unfaculty." Little data concerning their numbers or activities was collected prior to 1971 when the National Science Foundation formally included them in their surveys, but the National Academy of Sciences in 1969 chronicled their history in *The Invisible University: Postdoctoral Education in the United States*. According to that study, the definition of a postdoctoral is difficult, but includes:

> Appointments of a temporary nature at the postdoctoral level that are intended to offer an opportunity for continued education and experience in research, usually, though not neces-

DISPLAY 38 *Total R&D Expenditures at Educational Institutions and Number of Scientists[1] -- Selected Disciplines, 1972 - 1982 (Thousands of Dollars)*

Fiscal Year	Engineering	Biological Sciences	Chemistry	Physics
1972				
Expenditures	$341,362	$443,473	$108,122	$159,067
Full-Time Personnel	23,485	29,493	13,397	11,077
Average/Person	14,535	15,037	8,071	14,360
1975				
Expenditures	380,912	630,166	120,710	173,510
Full-Time Personnel	22,924	34,891	14,140	10,822
Average/Person	16,616	18,061	8,537	16,033
1976				
Expenditures	431,727	710,724	140,142	183,050
Full-Time Personnel	24,105	36,875	14,471	11,056
Average/Person	17,910	18,872	9,684	16,557
1977				
Expenditures	498,473	772,290	159,353	201,655
Full-Time Personnel	24,666	37,661	14,736	11,254
Average/Person	20,209	20,506	10,814	17,919
1978				
Expenditures	601,062	808,500	183,131	235,099
Full-Time Personnel	N/A	N/A	N/A	N/A
Average/Person	N/A	N/A	N/A	N/A
1979				
Expenditures	768,407	914,806	206,421	292,033
Full-Time Personnel	26,472	38,714	14,330	11,323
Average/Person	29,027	23,630	14,405	25,791
1980				
Expenditures	864,040	1,031,037	244,454	322,057
Full-Time Personnel	27,017	39,914	14,765	11,010
Average/Person	31,981	25,832	16,556	29,251
1981				
Expenditures	959,989	1,188,498	285,520	356,944
Full-Time Personnel	27,950	40,159	14,625	11,425
Average/Person	34,313	29,595	19,523	31,242
1982				
Expenditures	1,024,514	1,289,910	311,452	363,263
Full-Time Personnel	28,816	40,903	14,748	11,387
Average/Person	35,554	31,536	21,118	31,901
Percentage Increase, Average Dollars per Scientist, 1972 - 1982	144.6%	109.7%	161.7%	122.2%
Percentage Increase, GNP Deflator, 1972 - 1982	107.4%	107.4%	107.4%	107.4%
Growth in Average Dollars per Scientist Exceeds Increase in GNP Deflator by:	34.6%	2.1%	50.6%	13.8%

1. All personnel totals are for the following year; thus, those listed for 1972 are actually for 1973.

Source: National Science Foundation. 1984.

DISPLAY 39 *University of California Expenditures from Extramural Funds (Five-Year Intervals Beginning in 1950-51)*

Year	Total Expenditures Extramural Funds (current dollars)[1]	Total Expenditures (1983-84 Constant Dollars)	Ladder-Rank Faculty FTE[2]	Amount per FTE Faculty (1983-84 Constant Dollars)
1950-51	$3,334,208	$13,870,305	2,375[3]	$5,840
1955-56	7,355,156	28,331,325	3,643[3]	7,777
1960-61	46,191,764	161,929,848	3,116	51,967
1965-66	120,378,562	391,230,327	4,097	95,492
1970-71	207,180,910	543,186,910	5,988	90,713
1975-76	373,446,584	626,419,300	5,970	104,928
1980-81	591,486,798	683,522,144	6,186	110,495
1983-84	678,640,419	678,640,419	6,461	105,036
Annual Rates of Change:				
1950-51 to 1965-66	27.0%	24.9%	3.7%	20.5%
1965-66 to 1983-34	10.1%	3.1%	2.6%	0.5%
1950-51 to 1983-84	17.5%	12.5%	3.1%	9.2%
Total Percentage Change:				
1950-51 to 1965-66	3,510.4%	2,720.6%	72.5%	1,535.1%
1965-66 to 1983-84	463.8%	73.5%	57.7%	10.0%
1950-51 to 1983-84	20,253.9%	4,792.8%	172.0%	1,698.6%

1. Dollar figures do not include expenditures from the Atomic Energy Commission or the Department of Energy.
2. FTE Ladder-rank faculty include full, associate, and assistant professors plus instructors.
3. FTE Faculty for 1950-51 and 1955-56 are estimated, by applying the average FTE/headcount ratio for the other years to actual headcount for those two years.

Sources: University of California Financial Report: 1950, 1955, 1960, and 1965; Report on Activities Financed Through Contracts and Grants from Extramural Sponsors, 1970, 1976, 1980, 1983; and Statistical Summary of Students and Staff, 1950-51 to 1983-84.

sarily, under the supervision of a senior mentor. The appointee may have a research doctorate (e.g. PhD, ScD) or professional doctorate (e.g. MD, DVM) or other qualifications which are considered equivalent in the circumstances. A person may have more than one postdoctoral appointment during his career (p. 42).

In 1962, Bernard Berelson estimated the probable number of postdoctoral appointees in 1960 at 8,000. If his estimate is accurate, their numbers have almost tripled since that time. Berelson also estimated that the ratio of postdoctoral fellows to research grants was approximately one for each $100,000. That may have been true in 1960, but it clearly is no longer today. As Display 40 shows, the average at the University of California in 1983 was $253,149 in the biological and physical sciences, a number consistent with the national average of $263,945.

DISPLAY 40 Institutions Ranked by Science/Engineering Postdoctorate Utilization and Research and Development Funds Received from All Sources, 1983

Institution and National Rank	Number of Postdoctorates	Total R&D Expenditures (Rank in Parentheses) (000s)	Total R&D Expenditures in Engineering and the Natural Sciences[1] (000s)	Percent Science and Engineers of Total
National Totals	20,829	$7,744,954	$3,869,165	50.0%
1. Harvard	1,430	118,602 (11)	69,956	59.0
2. **UC - Berkeley**	652	118,951 (10)	65,655	55.2
3. Yale	608	100,269 (17)	46,906	46.8
4. **UC - San Francisco**	601	89,247 (21)	0	0.0
5. Stanford	545	163,031 (4)	93,489	57.3
6. University of Washington	490	133,523 (8)	54,124	40.5
7. **UC - Los Angeles**	453	113,266 (14)	40,396	35.7
8. **UC - San Diego**	432	147,008 (7)	105,073	71.5
9. Massachusetts Institute of Technology	427	200,349 (2)	181,895	90.8
10. University of Pennsylvania	399	113,499 (13)	48,330	42.6
40. **UC - Davis**	158	98,118 (19)	10,865	11.1
51. **UC - Irvine**	133	33,293 (80)	14,313	43.0
60. **UC - Santa Barbara**	114	22,884 (95)	18,594	81.3
70. **UC - Riverside**	82	37,236 (71)	6,352	17.1
115. **UC - Santa Cruz**	33	12,867 (137)	12,321	95.8
University of California Summary:				
Totals	2,658	$672,870	$273,569	40.7%
Percent of National Total	12.8%	8.7%	7.1%	
Average Expenditure per Postdoctoral	---	$253,149	---[2]	---

1. Includes engineering, physical sciences, environmental sciences, math and computer sciences, and biological sciences (excluding health sciences).
2. Data on postdoctorals are compiled by discipline and by campus, but not by both. Hence it is not possible to compute an average for the University in this category.

Source: National Science Foundation, 1985a and b.

During field investigations undertaken in conjunction with this report, Commission staff spoke with a number of postdoctoral researchers and their faculty supervisors at the San Diego and Santa Cruz campuses of the University, and from those discussions, it emerged that the closest parallels to postdoctoral research activity are probably medical internships and residencies, and legal clerkships. In engineering and the sciences today the work has become so complex, and the educational requirements for researchers so great, that virtually no scientific investigator can receive a faculty appointment without three to six years of postdoctoral experience. Today, the normal track to a professorship in the sciences involves seven or eight years of formal education culminating in the Ph.D. or comparable degree plus another three years or more as a postdoctoral. It is often the case as well that a faculty appointment cannot be secured until postdoctoral interns have demonstrated their proficiency in the field by publishing the results of their research and securing grants in their own names.

The space problem this poses for research universities may be significant if allowances for postdoctorals, research assistants, or laboratory technicians are not recognized or if existing standards for faculty and graduate assistants are insufficient. Excluding the University of California, only one public institution, the University of Washington, appears among the top ten institutions in the NSF data on postdoctoral utilization, and the Commission has received no information from that University on postdoctoral utilization. Nationally, only ten public universities outside California employ 200 or more postdoctorals, and data from them thus far has been limited or nonexistent. No data was received from six of them, and no data concerning research laboratory standards from the rest. Only three states offered the Commission any data on research laboratory space. All of them maintain more spacious allowances than California, but only New York formally recognizes postdoctorals in its space standards. The other two (Florida and Ohio) did not employ a great number of postdoctorals in comparison to their sizes (197 and 172 at their flagship universities, respectively), and so it is at least possible that those states have not encountered major problems.

Conclusion

This chapter has presented a series of tables showing the history of research funding in engineering and the sciences since the early 1950s. They indicate that the late 1950s and early to mid-1960s were times of extraordinary growth in expenditures, particularly from the federal government. They were also times of great growth in the use of postdoctoral fellows who once occupied a minor role on university campuses but are now integral to virtually all research efforts in the sciences, so much so that faculty appointments are difficult to obtain without several years of post-doctoral experience.

The position papers received from the University of California, in conjunction with the data from these National Science Foundation and other sources, appear to make a preliminary case for the liberalization of research laboratory space standards in the sciences. In spite of this, however, the Commission believes that a great deal of additional work remains before definitive recommendations can be made. The subject has become as complex as the disciplines themselves, and has led at least one state -- New York -- to establish separate standards for almost 200 different fields of knowledge.

In the next year or two, all of the claims and opinions surrounding the problem of research laboratories offered not only by the University but also by other interested parties will be collected and analyzed, and it is hoped that through that analysis, appropriate standards will be developed.

6 *Findings, Conclusions, and Recommendations*

THIS report has been prepared in response to 1985-86 Supplemental Budget Language that requested the Commission to study current space and utilization standards for classrooms, laboratories, and faculty research and office space in engineering and the biological and physical sciences, and to recommend changes in those standards, if necessary.

The Commission's response to this directive has included a review of the history of space and utilization standards in California (Chapter One); a discussion of the mechanics of those standards (Chapter Two); an overview of the standards or guidelines used by other states (Chapter Three); a presentation of the opinions and perspectives of California's public universities regarding the standards (Chapter Four); and an analysis of the changes that have occurred in the way research is conducted in engineering and the sciences (Chapter Five).

As noted in the Introduction, space and utilization standards constitute a subject of vast scope, the analysis of which has often involved several years of effort by teams of researchers. Given the current extent and complexity of the higher education enterprise in California, there can be little doubt that a thorough re-examination of the subject will require at least as much attention as has been required in the past. Because of that, the Commission believes that the Legislature was wise in calling for the study to be conducted in two phases; the first and present phase to be limited to a few fields, with the second to involve a plan for the study of all other disciplines. Nevertheless, a thorough examination of even a few fields, especially those as complex as engineering and the natural sciences, cannot be completed in only four months, and the Commission therefore believes that the recommendations offered in this chapter should be considered preliminary and used only on an interim basis until the larger study can be completed. The Commission suggests that this interim period include only the 1986-87 and 1987-88 fiscal years, after which the recommendations presented here should be replaced by new, and more permanent, guidelines.

Findings

California standards

1. Over the past 30 years, four major studies of space or utilization standards in California public higher education have been conducted: the Strayer Committee study of 1947, the McConnell Restudy of 1955, the Master Plan for Higher Education of 1960, and the Coordinating Council for Higher Education's study in 1966. Two of the four -- the Restudy and the Coordinating Council study -- dealt with both space and utilization standards; the Strayer study and the Master Plan considered only utilization.

2. California's current utilization standards for classrooms and teaching laboratories did not emanate from those studies but from legislative resolutions and Supplemental Budget Language recommended by the Legislative Analyst. Those standards require classroom usage of 53 hours per week with two-thirds of the seats in each classroom occupied, and teaching laboratory standards of 27.5 hours per week with 85 percent station occupancy at the lower-division level, and 22 hours per week at 80 percent station occupancy at the upper-division level.

3. Space standards for research laboratories at the University of California have not been altered since the recommendations of the Restudy were implemented in 1955, although they have been expanded somewhat through agreements between the University and the Department of Finance to account for the introduction of new disciplines.

4. Space standards for instructionally related research laboratories in the California State University exist through an informal agreement between the State University Trustees and the Department of Finance. These standards call for the State University, on a case-by-case basis, to receive 75 percent of the allowance accorded to the University of California.

5. Both the University of California and the California State University maintain comprehensive

inventories of the facilities in use on each of their campuses. However, these inventories are not consistently formatted, which makes comparisons between them difficult. Each California Community College district also maintains a space inventory, but according to the Chancellor's Office, they are not completely accurate in all districts.

6. Only the California State University undertakes an annual classroom and teaching laboratory utilization survey. This survey includes room-use and station-occupancy rates for each campus by hours of the day, day of the week, mean class size, weekly student contact hours per station, and related data.

7. In considering space guidelines, the most important determinant is the "space factor" of assignable square feet per weekly student contact hour (ASF/WSCH) -- a formula-generated number used to determine how many square feet of floor area should be allowed for each hour each student uses a station in a classroom or laboratory each week.

Standards of other states

8. The Commission's national survey compiled for this report produced data from 25 states and usable data from 24. Twelve of these states reported data directly, while data for the remaining 12 were obtained from a 1981 survey conducted by the Nebraska Coordinating Commission for Higher Education. Of the 24, most reported utilization data, 14 reported both utilization data and space standards for classrooms and teaching laboratories, and three reported space standards for faculty research laboratories.

9. Most of the surveyed states employ "space factors" as defined in Finding 7 above. One -- New York -- uses a formula based on assignable square feet per full-time-equivalent student, but that formula also depends on a calculation of contact hours and is therefore similar.

10. Most states appear to prefer the term "guidelines" to "standards," since the former allows greater flexibility to capital outlay planners. It is common practice nationally to issue guidelines as targets or goals rather than formal requirements.

11. With the exception of Oklahoma -- based on data reported by Nebraska and only partially confirmed by Commission staff -- all of the states surveyed for this study report classroom utilization guidelines of between 30 and 35 hours per week with between 60 and 70 percent station occupancy. The mean guidelines for the 16 states that reported formal standards are 31.1 hours per week with 63.1 percent utilization, compared to California's 53 hours at 67 percent.

12. Also excepting Oklahoma, the states surveyed for this study report teaching laboratory utilization standards of between 16 and 30 hours per week with between 70 and 85 percent utilization. The mean standards for the 15 states that reported formal standards are 21.7 hours at 78 percent utilization compared to California's standards of 27.5 hours at 85 percent for lower division and 22.0 hours at 80 percent for upper-division laboratories.

13. As noted in Finding 8, three states reported formal standards for research laboratories -- Florida, New York, and Ohio. All three provided allowances greater than California's, with the additional square footages allowed varying between 10 and and 80 percent, depending on the state and the discipline. California's standards contain specific space allotments for graduate students. Florida also does and Ohio may do so -- but the data they provided were not sufficiently detailed to permit a determination of that factor. In New York's case, specific allotments are granted for both first- and second-stage graduate students (master's and doctoral) and for postdoctoral fellows, the latter being included within the guideline for Ph.D. students. When all the components are analyzed, it appears that New York's guidelines are between 15 percent (for engineering) and 90 percent (for physics) more generous than California's, with the biological sciences falling in the upper third of that range at between 60 and 80 percent, depending on the subdiscipline.

Trends in funding

14. Extensive data from National Science Foundation reports dating back to the early 1950s indicate that research funding for higher education has grown from $255 million in 1953 to $7,261 million in 1982. This is an increase of 708.2 percent over inflation for the 30-year period.

15. Research funding at the University of California appears to have grown faster than the national rate, increasing by a factor of over 200 between 1950-51 and 1983-84 compared to a factor of 28 nationally between 1953 and 1982. Annual percentage rate increases are 12.2 percent for the nation and 27.0 percent for the University. These figures for national and University trends are not strictly comparable, since the University's include non-federal funding sources, but they strongly suggest that the University has been among the nation's most successful competitors for research grants.

16. In response to the Commission staff's request, the University drafted three papers describing the changes that have occurred in the nature of scientific research during the past several decades. These papers indicate that at least four major changes have occurred since the existing research laboratory space standards were formulated in 1955: (1) Many new disciplines, such as microbiology and laser physics, have emerged with unique space and equipment needs; (2) The amount, size, and sophistication of scientific equipment has altered space needs, often increasing space requirements; (3) Research projects are now seldom conducted by one or two individuals as in the past, but instead involve faculty direction of teams of graduate students, postdoctoral fellows, and laboratory technicians; and (4) Postdoctoral fellows have become integral participants in most research projects.

17. While California's existing space standards for research laboratories provide allocations for faculty members and graduate students, they do not recognize the presence of postdoctoral fellows.

18. At the present time, capital outlay requests by the University of California and the California State University are heavily oriented to engineering and natural science facilities. The Regents' request for 1986-87 calls for 66 percent of the expenditures to be in these fields. For the State University, the comparable figure is 56 percent.

Institutional perspectives

19. In a written statement concerning the existing standards, the California State University offered its opinion that current classroom and teaching laboratory utilization standards are excessively restrictive and should be liberalized to conform to national norms. It also recommended that guidelines should be implemented for a greater number of disciplines than presently covered, that more space should be provided for faculty offices, and that the 75 percent allowance for research laboratories should be formalized.

20. In outlining its position on the existing standards, the University of California stated that its most serious problem is the need to provide more space for faculty research laboratories, particularly in the biological and physical sciences. Related to this problem is the need to recognize formally the existence of postdoctoral fellows and to provide space for their research work. The University also believes that utilization standards for classrooms and teaching laboratories should be liberalized, especially the classroom standards.

Conclusions

1. Given the four facts that (1) California's last major study of space and utilization standards for classrooms and teaching laboratories was conducted in 1966, (2) its last study of space standards for research laboratories was undertaken in 1955, (3) its existing legislatively mandated utilization standards were not derived from a formal examination of the subject, and (4) California's standards are substantially divergent from those in other states, there is a strong probability that the current standards are outdated and in need of revision.

2. The Commission's survey of other states revealed that California's classroom utilization standards are 80.1 higher than the average of the 16 states that reported formal standards. Most of these states base their standards on an 8:00 a.m. to 5:00 p.m. day, while California uses an 8:00 a.m. to 10:00 p.m. period; but even for those few states that use the 8:00 a.m. to 10:00 p.m. standard, California's standard remains about 40 percent higher. From these data, it is apparent that California's classroom standards are inconsistent with national norms by a substantial amount.

3. For teaching laboratories, California's standards are also the highest of any state surveyed, excep-

ting only Oklahoma and Colorado. The divergence, however, is not as great as for classrooms, and it is therefore concluded that while a downward revision in California's standard is reasonable, it should not be as great as for classrooms.

4. In every state surveyed, actual utilization falls short of the specified standards -- a fact which suggests that standards should be set at a high level in order to encourage greater efficiency.

5. Space-per-station standards for classrooms and laboratories in other states do not vary significantly from those found in California. However, once the utilization standards are applied to produce the "space factor" of assignable square feet per weekly student contact hour, California's standards produce fewer square feet of allowable space in every case except Oklahoma, data from which is as yet unconfirmed.

6. Although the data are limited, the available evidence indicates a need to liberalize the square footage allowances for faculty research laboratories in the natural sciences. There is a less compelling case for such liberalization in engineering. The area allowed for faculty members may be too stringent by only a small amount, and in fact is more generous than the amount allowed by New York, but once allowance is made for graduate students and postdoctoral fellows, there appears to be a need to increase California's allotment by a substantial amount.

7. Because most scientific research is now conducted by teams of researchers, rather than by individual faculty members with one or two graduate students, it is reasonable to institute space allocations for those additional people who now occupy faculty research laboratories. This should be done in two ways: (1) changes should be made in California's space guidelines to account for differences between beginning and advanced graduate students, and (2) the presence of postdoctoral fellows should be formally recognized in California's guidelines, since they are now such integral members of the University's scientific research teams.

8. Capital planning is a complex process involving thousands of decisions as to amounts of space, design parameters, and equipment configurations. Because of that, the Commission believes that some flexibility within and between disciplines and campuses is essential, and that the term "guidelines" is therefore preferable to "standards." The former implies targets or goals to which exceptions can be made if sufficient justification is presented. The latter implies a rigidity that may actually hinder efficient planning.

Recommendations

The Commission offers the recommendations below with several caveats:

- First, as noted earlier in this report, space and utilization guidelines constitute a highly complex subject, and it is therefore not possible to offer definitive recommendations for permanent changes in the existing formulas after only a three- or four-month examination. Within that span of time, the major sources of information, of necessity, were the opinions of officials in California and out-of-state institutions, rather than extensive field visits or comprehensive utilization surveys.

- Second, as a preliminary step, this report places considerable reliance on national data. In doing so, however, the Commission recognizes that the data from some states are unconfirmed, while that from others are too general to be directly applicable to California. Those data that are both available and reliable strongly suggest that California's standards may be too restrictive, but that conclusion must be subject to further investigation.

- Third, the mere fact that California's standards are substantially different from those found in other states does not, in itself, require California to change. California's system of higher education is unique in many respects, and doubtless will remain so.

- Fourth and finally, if the following recommendations are implemented, their effects will need to be monitored closely; and those effects, in turn, will almost certainly influence subsequent recommendations. Accordingly, the Commission proposes in its first recommendation that these guidelines be considered only as preliminary and interim measures.

1. **Any changes in California's existing space and utilization standards should be implemented as interim measures pending com-**

pletion of the second phase of the Commission's study of the subject. The interim period should encompass only the 1986-87 and 1987-88 fiscal years and affect the following types of State-funded capital outlay projects: (1) the preliminary planning (P) and working drawing (W) funding during 1986-87 and 1987-88, and (2) the construction (C) proposals funded in 1987-88 that are related to the preliminary planning and working drawing proposals funded in 1986-87.

This recommendation proposes that the following guidelines expire as of July 1, 1988. The guidelines, as that term is defined in Conclusion 8 above, should apply to all three public segments of higher education.

2. **The existing classroom utilization standard of 53 hours per week at 66.7 percent station utilization is excessively restrictive and should be reduced. For 1986-87 and 1987-88, California should change to a guideline about 10 to 15 percent less strict than the existing utilization standard.**

   Even in comparison to those few states that maintain an 8:00 a.m. to 10:00 p.m. utilization guideline, California's standard is about 40 percent higher. This recommendation will continue to keep California's guideline at or near the very highest in the nation, while reducing it slightly.

3. **The existing teaching laboratory utilization standards of 27.5 hours per week at 85 percent (lower division) and 22 hours per week at 80 percent (upper division) are also unreasonably high and should be reduced by approximately 5 percent for the interim period.**

   California's standard for teaching laboratories is approximately 20 percent higher than the average for the rest of the nation. While this does not indicate that California should strive for the national average *per se*, the change will reduce the guideline to a more reasonable level.

4. **Existing space allocations for natural science research laboratories at the University of California should be increased by a substantial amount, probably by between 25 and 50 percent for the interim period.**

   This increase is justified for two reasons: (1) the need to recognize the evident differences in laboratory time required to be spent by first-stage compared to second-stage graduate students; and (2) the presence of postdoctoral fellows. Both second-stage graduate students (doctoral candidates) and postdoctoral fellows are extremely active participants in research projects, often more so than faculty, since they are able to participate in research virtually full time.

   The division between first- and second-stage graduate students is warranted because of the dramatic changes that have occurred in graduate education in the sciences since 1955. The increase for postdoctoral fellows is further justified, since they currently constitute a valuable human capital resource to both the State and the University, many securing faculty appointments upon completion of their training and making further contributions as scientists and teachers. Most postdoctoral fellows also secure research grants in their own names, thereby contributing to the economic welfare of both their campus and the State. For these reasons, it is in the State's interest to encourage postdoctoral involvement in the University's programs and to provide them with facilities. The recommended increase is actually somewhat less generous than that allowed by New York, where postdoctoral fellows are officially recognized, and where the spacial ratio between them (together with advanced graduate students) and first-stage graduate students is often two or three to one.

5. **The existing standards for engineering research laboratories should not be changed at this time.**

   There is less of a divergence between California's standards and those found nationally in engineering research laboratories. In part, this is because California's current research laboratory standards in engineering are higher than for the natural sciences. While the Commission believes that it is just as important to recognize postdoctoral fellows in engineering as in the natural sciences, specific changes in the total amount of research laboratory space allocated to engineering does not appear to be warranted at present. In part, this is because postdoctoral fellows are not as involved in engineering as in the natural sciences. Accordingly, specific changes

in the guidelines for engineering should be delayed until the second phase of the Commission's study is completed.

6. **The current policy that the California State University receives 75 percent of the University of California's research laboratory allotment, justified on a case-by-case basis, should be officially recognized.**

   For several years, the State University has maintained this informal agreement with the Department of Finance, but for this interim period, that agreement warrants official recognition.

7. **No change in faculty office space allocations should be made at this time.**

   For this first stage of the space and utilization study, insufficient evidence was available concerning faculty offices. Accordingly, the Commission recommends no change in these allocations during 1986-87 and 1987-88.

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CALIFORNIA POSTSECONDARY EDUCATION COMMISSION

THE California Postsecondary Education Commission is a citizen board established in 1974 by the Legislature and Governor to coordinate the efforts of California's colleges and universities and to provide independent, non-partisan policy analysis and recommendations to the Governor and Legislature.

Members of the Commission

The Commission consists of 15 members. Nine represent the general public, with three each appointed for six-year terms by the Governor, the Senate Rules Committee, and the Speaker of the Assembly. The other six represent the major segments of postsecondary education in California.

As of 1986, the Commissioners representing the general public are:

Seth P. Brunner, Sacramento, *Chairperson*
C. Thomas Dean, Long Beach
Seymour M. Farber, M.D., San Francisco
Patricia Gandara, Sacramento
Ralph J. Kaplan, Los Angeles
Roger C. Pettitt, Los Angeles
Sharon N. Skog, Mountain View
Thomas E. Stang, Los Angeles, *Vice Chairperson*
Stephen P. Teale, M.D., Modesto

Representatives of the segments are:

Sheldon W. Andelson, Los Angeles; representing the Regents of the University of California

Claudia H. Hampton, Los Angeles; representing the Trustees of the California State University

Beverly Bernedict Thomas, Los Angeles; representing the Board of Governors of the California Community Colleges

Jean M. Leonard, San Mateo; representing California's independent colleges and universities

Darlene M. Laval, Fresno; representing the Council for Private Postsecondary Educational Institutions

Angie Papadakis, Palos Verdes; representing the California State Board of Education

Functions of the Commission

The Commission is charged by the Legislature and Governor to "assure the effective utilization of public postsecondary education resources, thereby eliminating waste and unnecessary duplication, and to promote diversity, innovation, and responsiveness to student and societal needs."

To this end, the Commission conducts independent reviews of matters affecting the 2,600 institutions of postsecondary education in California, including Community Colleges, four-year colleges, universities, and professional and occupational schools.

As an advisory planning and coordinating body, the Commission does not administer or govern any institutions, nor does it approve, authorize, or accredit any of them. Instead, it cooperates with other state agencies and non-governmental groups that perform these functions, while operating as an independent board with its own staff and its own specific duties of evaluation, coordination, and planning.

Operation of the Commission

The Commission holds regular meetings throughout the year at which it debates and takes action on staff studies and takes positions on proposed legislation affecting education beyond the high school in California. By law, the Commission's meetings are open to the public. Requests to address the Commission may be made by writing the Commission in advance or by submitting a request prior to the start of a meeting.

The Commission's day-to-day work is carried out by its staff in Sacramento, under the guidance of its director, Patrick M. Callan, who is appointed by the Commission.

The Commission issues some 30 to 40 reports each year on major issues confronting California postsecondary education. Recent reports are listed on the back cover.

Further information about the Commission, its meetings, its staff, and its publications may be obtained from the Commission offices at 1020 Twelfth Street, Third Floor, Sacramento, CA 98514; telephone (916) 445-7933.

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ONE of a series of reports published by the Commission as part of its planning and coordinating responsibilities. Additional copies may be obtained without charge from the Publications Office, California Postsecondary Education Commission, Third Floor, 1020 Twelfth Street, Sacramento, California 98514; telephone (916) 445-7933.

Other recent reports of the Commission include:

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85-28 Comments on the California Community Colleges' Library Space Study: A Report to the Board of Governors of the California Community Colleges in Response to Budget Control Language in the 1984-85 Budget Act (April 1985)

85-29 Reauthorization of the Federal Higher Education Act of 1965: A Staff Report to the California Postsecondary Education Commission (July 1985)

85-30 Director's Report, July-August, 1985: Appropriations in the 1985-86 State Budget for the Public Segments of Postsecondary Education (August 1985)

85-31 Faculty Salaries and Related Matters in the California Community Colleges, 1984-85 (September 1985)

85-32 Annual Report on Program Review Activities, 1983-84 (September 1985)

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86-1 Director's Report, January 1986: Enacted and Vetoed Higher Education Legislation from the 1985-86 Regular Session of the Legislature; Two-Year Bills to be Considered in 1986; 1985 Fiscal Legislation Affecting Higher Education (January 1986)